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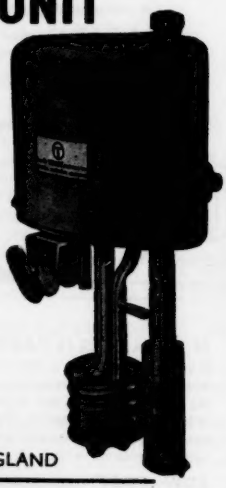

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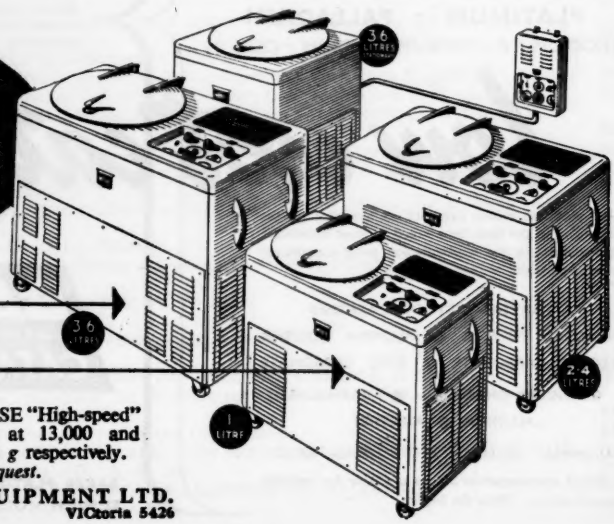

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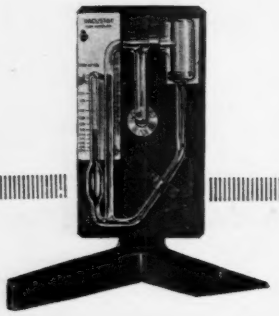

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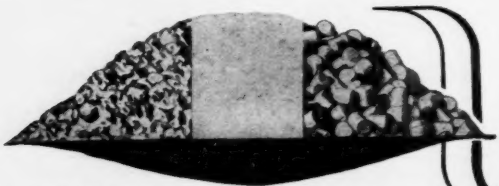

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NATURE

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INDUSTRY AND TECHNOLOGICAL TRAINING

IN recent years the role of the research associations in Britain in providing the industries they serve with trained scientific and technological staff has been increasingly recognized and was indeed the subject of a private conference in London in November 1953, which was attended by members of the Advisory Council for Scientific and Industrial Research, the chairmen and directors of the research associations and some representatives of the universities. Although the discussions at this conference covered a wide field, they were concerned more with the relations between the universities and technical colleges and the research associations than with those between the latter and industry. The contribution of the research associations to technical, and more especially to technological, education has since received much attention, and may well become even more important with the increasing stress laid upon the 'sandwich system' in the White Paper on Technical Education and elsewhere.

This contribution is essentially one made from within industry. It could assist, for example, the university-trained scientist to acquire technical knowledge or technological skill which he would find difficult to obtain either in the smaller firm or even in the best-equipped college of technology. It needs to be remembered in discussing the expansion of technological or technical education that there are limits to the acquisition of such knowledge before entrance to industry, limits set by the nature of the technical skill or knowledge concerned and by economic factors, quite as much as by the curriculum of a college or university. The point has been well made at some of the conferences with the universities arranged by the Federation of British Industries, but without its full implications being brought out as clearly as is done by Prof. Hyman Levy in the challenging article "The Chaos in Scientific Recruitment" which he contributed to the *Rationalist Annual* of 1956. Levy argues that if we are to meet the demands for trained man-power which a modern industrial community makes, we must solve the problem of providing for the transition to the scientific or theoretical side of those whose scientific ability or desires only develop after practical experience of industrial or commercial life. To do this we must have a clear understanding of the outlook and experience of the young factory worker, and Levy suggests that an extension of the scope, at once educational, technical and scientific, of the considerable scientific establishments or research laboratories which most of the larger industries already possess, would provide the basis for what is needed.

Prof. Levy is undoubtedly right in insisting that industry must accept a larger share of the responsibility for initiating and developing the institutions that are required to supply the trained man-power that a modern technological community needs; but while he does not attempt to outline the details of a definite scheme, the extent to which it can and should be given within industry requires rather more consideration than it has yet received. To some extent the attention given to automation in recent months has helped here, for it has been obvious that some of the techniques involved can only be acquired within industry. This has also been very noticeable in the development of nuclear energy. In spite of the great activity in nuclear physics at the universities, the Atomic Energy Authority has had to assume, through its Reactor School at Harwell and its Isotope School, a major share of responsibility for providing industry with the staff it requires if it is to take its full part in exploiting the commercial applications of nuclear energy. In its second annual report, the Authority stated that it was considering what expansion should be made in its training facilities, particularly for scientific and technical staff, in the light of the White Paper on Technical Education.

This aspect of technical education—that of the training given within industry—was rather overlooked in the two debates in the House of Commons on July 25 and August 2. In the former, indeed, Mr. F. Peart emphasized that technical education cannot be divorced from the general educational system, and Sir David Eccles stressed the importance of collaboration between the technical colleges and the modern secondary schools. It was suggested by Mr. J. Hall that there might be a tendency to overlook the part of the grammar schools in the production of first-class scientists and that the Ministry might be differentiating too rigidly between technical and scientific training on one hand and grammar school training on the other; but apart from an incidental reference by Mr. Hubert Ashton, the co-operation of industry was scarcely mentioned, even by Mr. A. Skeffington in opening the adjournment debate on technical education on August 2 and referring to the sandwich courses. Mr. Dennis Vosper, Parliamentary Secretary to the Ministry of Education, who replied in both debates, agreed that the means of financing sandwich courses is at the moment difficult and said that the Minister would be issuing advice about the financing of students in such courses. He gave figures showing increases in the numbers of students taking sandwich courses, and said that the signs for the coming year are of further increases. The fall in numbers attending full-time degree courses was largely due to the decrease in further educational training schemes and the general decrease in pressure on the universities and technical courses in recent years. He said he has no evidence that the provision of technical colleges and the supply of teachers and of students are not, in fact, keeping pace one with another. The number of technical State scholarships has been increased to 150 and the Minister is prepared to increase this figure if the number of students is forthcoming.

In neither debate was convincing evidence adduced that the increase in fees for non-vocational courses in further education is unjustified or likely to be detrimental, but the discussion would have been a good deal more realistic in the light of considerations advanced by Mr. J. Wellens in his recent book "Education and Training in Industry"*. Mr. Wellens is concerned with current practice in what he describes as industrial training—the training which industry gives to its new entrants at the level of craft or staff apprentices, to its operatives, or to those destined to be supervisors, foremen or managers. He reviews such practice with three aims. First, to set down a system which could reasonably and currently be regarded as basic; second, to propound the doctrine of integrated training; and third, to indicate the necessity of a framework of organization which will permit and promote the efficiency of training.

Mr. Wellens writes from the point of view of a 'training officer' in industry, with responsibility for seeing that an adequate supply of correctly equipped employees is available at all times and at all levels in the organization. He is aware, too, that this should be done so as to provide a balanced, contented and efficient labour force, one with an immediately available pool from which promotions can readily and adequately be made, yet not so large that frustration or wastage easily arises. He is aware, too, of the implications of automation, with its growing demand for more highly trained technicians and for technologists of a very high order, while that for the manual worker decreases.

If this is to be achieved, the training officer must do much more than operate a routine training system. He must see industry as a way of life, not merely as a means of earning a livelihood. He must be able himself to make some creative contribution, and however suited the educational system of the country may be for providing the quality of recruits required, he should be capable of formulating precisely the further contribution which industry must supply, and securing from the management the conditions in which that training can most effectively be given.

Mr. Wellens begins by formulating the general principles which should normally govern any training scheme. Its purpose should be clearly defined, and also the relation between the training department and the personnel department. It should be recognized that something more is needed than the inauguration of facilities for training, and that training is a continuous process but nevertheless not the prime concern of industry; and while the purpose of training should not be narrow, it must be judged according to the way in which it furthers the primary purpose of industry.

Three further principles are particularly important, not merely because their neglect often brings training into disrepute, but equally because of their relevance elsewhere in the field of technical education. Training, Mr. Wellens points out, does not give men an automatic right for preference in promotion. Three factors are involved: technical knowledge, practical experience and personality. All three are in some measure indispensable. Again, he insists on the importance of consultation. Training officers do not operate in a vacuum. Further, training is concerned with future rather than present needs, and a training officer must have vision and imagination and be well abreast of modern practices and trends.

All these three principles are important in planning the expansion of technical and of technological education. The last is one of the essential reasons why at the higher levels some training must always be given within industry rather than in a college of technology, however well equipped it may be. It is not merely the cost of equipment that makes it difficult for the latter to be thoroughly up to date. All three principles are supported, as is Mr. Wellens's insistence both on the importance of regarding all training as a unity and of an appropriate organization within which training can be effected, by the recent report on management succession from the Acton Society Trust and by Lord Heyworth's recent observations on training for management, when he also insisted on the importance of co-operation between industry and the universities and that an essential part of such training must be given within industry and indeed on the job itself.

That is indeed recognized by Mr. Wellens, for although much of his book is concerned with the training of apprentices and operatives and stresses the need for fresh thinking about the appropriateness of existing practice to modern conditions—on the part of the trade unions as well as of management and educational institutions—in his chapters on university study and scholarship schemes and on management training he discusses just those problems of the university graduate in industry and the provision of a steady supply of managers of high ability with which Lord Heyworth and the Acton Society Trust were concerned. The principles which Mr. Wellens advocates could go far to assist the effective utilization of the university graduate in industry and the elimination of that serious wastage on which the Acton Society Trust laid such stress in its report. Wastage will only be eliminated if there is a definite plan within a firm for developing managerial talent as well as discovering it; and while it is clear that the training officer can play a big part here, Mr. Wellens does not overstress that part. He emphasizes rather that the solution is to be found in terms of organization rather than in terms of educational technique.

There are two points to be noted here. First, there is room for further inquiry into the personality aspects of management rather than the academic aspects. The Acton Society Trust has by no means exhausted the subject, and there is room for further studies by the Trust as well as by the British Institute of Management. Second, while Mr. Wellens agrees that an essential part of training for management must be given on the job, he is careful to point out that such training involves forethought and deliberate effort on the part of the principal concerned, as well

* Education and Training in Industry. By John Wellens. Pp. x + 142. (Manchester: Columbine Press, 1955.) 17s. 6d. net.

as careful control and organization and guidance. It must be planned training just as much as if it were given in an educational establishment.

Mr. Wellens does not attempt to forecast the fundamental form which training for management in Britain may assume when, and if, it becomes stabilized. He displays the broad field over which co-operation is required between industry, the trade unions, the universities and the colleges of technology. He indicates the need for fresh thought as well as for definite organization, and his book is a stimulating contribution in that direction which should not be neglected either by those responsible for shaping the expansion of technical or technological education, or by those concerned with the organization of training within industry itself.

While, however, Mr. Wellens recognizes the main factors involved and the ways in which a wide outlook and broad general education could be encouraged at the different levels, on one key problem he scarcely comments, namely, the provision of teachers. This is a vital matter in the development of sandwich courses, in the expansion of technical education and in the organization of training in industry itself along the lines which Mr. Wellens suggests. It could well be true that there are sections of industry where much more could be done by way of co-operation with the universities or the colleges of technology, in the release of staff as part-time lecturers, as well as in the organization of its own training schemes; but it must be remembered none the less that there are limits to what industry as such can do. Training, as Mr. Wellens rightly points out, is a subordinate and not a primary function of industry.

The supply of teachers, especially of science and technology, thus remains a key problem in the development of training within industry, as it is also in the expansion of technical and technological education. The co-operation of industry may help to alleviate the situation at some points but scarcely to remove the existing shortage. Moreover, very careful thinking and organization will be required if the scientific establishments of industry—and especially its research establishments—are to undertake the educational responsibilities which Prof. Levy suggests. Admittedly, the teacher derives inspiration from close association with the advancement of knowledge; but it is by no means certain that the way in which teaching and research are at present associated is the most effective for teaching or for research. It may well hinder, as Dr. R. Coulborn pointed out twenty years ago, the development of the valuable personal relation between teacher and student, turn the energy of the undergraduate into work for which he is unsuited and which he is unlikely ever to use, as well as waste the time of the teacher and obstruct his own original thinking or research.

It is rightly being urged that the technical colleges and colleges of technology in Britain should be staffed and equipped so as to permit more original research in technical fields being undertaken, and it is true that they could often help industry considerably in this way. Both here and in the research associations, however, there is need for further inquiry and thought, not merely as to the type of problems which could be investigated in this way, but also as to the exact relation between research and teaching. Here, and in the universities also, this question needs to be re-examined in the light of the principle that scarce material must be used with forethought and economy; and it could well be that further critical and unprejudiced inquiry could point to ways in which more effective use could be made of the limited numbers of teachers of science and technology in Britain, as well as in turning larger numbers of promising students into such fields and training them more efficiently and speedily.

NAPHTHALENESULPHONIC ACIDS AND STEROIDS

Elsevier's Encyclopaedia of Organic Chemistry
Edited by Dr. F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 12*B*: Naphthalene. *A*. Compounds Containing One Naphthalene Nucleus. Sulphonic Acids: SO_3H in Side Chain; One SO_3H in the Nucleus. Pp. 4841–5686. (1955.) £21 10*s*.

Vol. 14, Supplement. Steroids: Substituted Monohydroxyl Compounds; Polyhydroxyl Compounds. Edited by A. Georg, with the assistance of M. Georg-Plant, Dora Stern and J. Meyer. Pp. 1869*s*–2214*s*. (1956.) £9 10*s*.

(Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd.)

THESE two parts in "Elsevier's Encyclopaedia of Organic Chemistry" take their respective volumes a stage nearer completion. In the first the literature is stated to be covered up to 1944 and the literature concerning the structure of compounds up to 1955, while in the second the coverage is up to 1946 with reference to papers on structure and configuration up to 1955. As might be expected, in view of the subjects treated, references to publications of the past decade are more abundant in the second of these parts than in the first.

Naphthalenesulphonic acids and their amino- and hydroxy-derivatives are, to the dyestuffs chemist, among the most important derivatives of naphthalene, and this part of Vol. 12*B* deals with such compounds containing one sulphonic acid group and also with azo dyes related to them. In regard to the latter, it is useful to find references to their numbers in the "Colour Index" and in "Farbenstofftabellen", and it is also to be noted that the lists of references include not only titles of scientific periodicals but also some of the more important patent specifications and such well-known monographs as those of Fierz-David and of Venkataraman. True to the traditions of the "Encyclopaedia", interesting information about biological properties is scattered through the part; thus, there is reference to the plant growth-promoting action of such compounds as the sulphonic acid analogue of 1-naphthylacetic acid; we read that 2-naphthol-6-sulphonic acid is only moderately toxic to body lice; and there is a brief digest of the voluminous literature on the biological properties of congo red. A useful feature is the list of trivial names of naphthalenesulphonic acids and their derivatives. This includes also the compounds with more than one sulphonic acid group, which are not

otherwise dealt with in this part. It is valuable to have so much information about the sulphonated naphthalene derivatives arranged in such compact and easily accessible form, even though much of the material is already summarized in monographs and other publications.

The Supplement to Vol. 14, on steroids, "comprises the halogen and nitrogen substituted monohydroxylated compounds with one OH in the ring system, and all polyhydroxylated compounds, having at least one OH in the ring system, with or without halogen or nitrogen substituents". Hence there is included the addition products of sterols with halogens and halogen acids, the nitro-, amino- and azo-derivatives of the sterols, the œstradiols, œstratriols and diols and triols of the androstane, pregnane, cholestane and ergostane series. Configurations are given so far as they are known, and the work will be an invaluable compendium to those interested in steroid chemistry. There are the usual tables of physical constants of the more important groups of compounds, references to physiological properties, usually œstrogenic or androgenic activity, and the part is liberally supplied with editorial footnotes clearing up points of obscurity or confusion in the original literature.

Both parts reach the standard of excellence of production to which users of "Elsevier's Encyclopaedia" are now well accustomed. J. W. Cook

REACTIVITY OF COLLAGEN

The Chemistry and Reactivity of Collagen

By K. H. Gustavson. Pp. ix+342. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 8 dollars.

Dr. K. H. GUSTAVSON was awarded the Grand Gold Medal by the Royal Swedish Academy of Technical Sciences in 1955 for his pioneering contributions, which form the background to the present monograph. A knowledge of the chemistry and reactivity of the fibrous protein collagen is of fundamental interest to workers in the fields of biochemistry, medicine and leather technology. The book gives an able review of widely dispersed information in the light of the modern theories of protein reactions. Special attention is given to reactions which form the basis for the processing of skin prior to tanning and for the making of gelatin.

After a general survey of the chemistry of proteins, including the methods for estimating the terminal groups, a clear picture of the composition of collagen in terms of amino-acids is given, along with a discussion of their sequence. The parts played by X-ray techniques, electron microscopy and birefringence in revealing the architecture of this protein are lucidly discussed, showing the developments which have occurred since 1940 when W. T. Astbury put forward his original model for the configuration of the polypeptide chain.

The amphoteric ionic structure gives rise to many of the properties of the collagens. The charged centres of the protein zwitterion exist in electrostatic balance with each other at the isoelectric point. The methods for the determination of the latter are discussed critically, and it is shown that its location with hide collagen is a function of the alkali pretreatment. Acids and bases disturb this balance, and the reactions which occur are examined in detail because they are of fundamental importance for the understanding of the general reactivity of collagen. The meanings of the various titration curves are clearly explained.

The cohesion of the collagen molecule is, of course, one of its characteristic features. This is due to electrovalent salt links and hydrogen bonds, but the desirability of increasing our very limited knowledge of the distances between the reactive groups is rightly emphasized. The significance of this structural restraint is clearly explained in discussing the Procter–Wilson extension of the Donnan effect in connexion with osmotic swelling. The lyotropic effects of neutral salts, urea, weak acids and phenols are shown to be intimately connected with hydrogen bonding.

The various aspects of the thermal shrinkage of collagen and connective tissues are adequately discussed with reference to the different types of collagen. The shrinkage temperature measures the hydrothermal stability. Tanning agents increase its value due to the formation of cross-linkages. The reactivity of collagen is profoundly influenced by the inactivation of its amino and carboxyl groups, and a comprehensive account of the relevant researches in this field is given. The splitting of proteins into peptones, polypeptides and amino-acids by proteolytic enzymes is vitally important when they are used for nourishment. It is also an important reaction in their decomposition when they undergo putrefaction. The effects of proteinases on native and tanned collagen are therefore discussed. The final chapters deal with the problem of unhairing, the conversion of collagen into gelatin and some physicochemical aspects of its reactions with tanning agents, which includes an account of the contributions of the monolayer technique to the problem of tannage.

The monograph is most interesting to research workers in the field of collagen and will serve as a useful book of reference for many years to come. It covers the literature up to late in 1954, and the views of the various investigators are on the whole well covered. The index is good, but there are a considerable number of typographical errors. Those who are not specialists will, however, find it difficult to read because the descriptions of the experimental methods are very brief and it is assumed that the reader is familiar with the underlying theory.

Donald Burton

AMERICAN COLOUR TELEVISION

Color Television Standards

Selected papers and records of the National Television System Committee. Edited by Donald G. Fink. (McGraw-Hill Television Series.) Pp. xii+520. (London: McGraw-Hill Publishing Company, 1955.) 64*s*.

This book is a sequel to "Television Standards and Practice" (1943) by the same author, the latter comprising information produced by the first nine panels of the then recently formed National Television System Committee in the United States. This Committee had been allocated the task of formulating suitable standards for monochrome television transmissions so that the Federal Communications Commission could accept them officially. The first Committee, which formulated the monochrome standards, issued a set of volumes comprising 2,000 pages, while the second, the findings of which

are summarized in the volume under notice, issued a number of volumes totalling 4,100 pages. This work was the result of co-operation between more than thirty organizations comprising the greater part of the American radio and electronics industry. It is perhaps interesting to note that, whereas the formulation of monochrome standards required 2,000 pages, the formulation of colour standards, which of course are based on monochrome, required *in toto* 6,000 pages—three times the number required for monochrome. Does this ratio depend upon the fact that ideal colour television requires the transmission of three times the information needed for monochrome ?

The book is divided into ten chapters and two appendixes. Chapter 1 covers the later history of colour television and includes a useful set of questions and answers and references to appropriate parts of the book. Chapter 2, which the serious reader is recommended to read first, includes a very clear description of the American colour television signal specifications. A considerable proportion of the information contained in this chapter may be found in the *Proceedings of the Institute of Radio Engineers*, 42, No. 1; January 1954. Chapter 3 contains an abbreviated description of some subjective tests which have already been described in greater detail (*Proc. Inst. Rad. Eng.*, 30, No. 8; August 1952), and a lengthy set of questions and answers which is worth while reading if only to gauge the extent of disagreement which still exists with regard to many fundamental subjective questions relating to human vision.

Chapter 4 (which begins on p. 102 and not on p. 212 as shown in the list of contents) is entitled "The Color Video Signal" and contains a large number of technical monographs of the National Television System Committee, nearly all of which have been published elsewhere (*Proc. Inst. Rad. Eng.*, 30, No. 8, August 1952; and 41, No. 7, July 1953). The serious student of colour television will find this chapter of immense value, as it covers most of the theoretical and practical work which led to the formulation of the American colour television signal specifications.

Practically all Chapter 5, "The Color Synchronizing Signal", is taken up by the excellent mathematical study, "Color-Carrier Reference-phase Synchronization Accuracy in N.T.S.C. Color Television", by Richman; once again, this paper has appeared elsewhere (*Proc. Inst. Rad. Eng.*, 42, No. 1; 1954).

Chapters 6, 7 and 8 will interest mainly those responsible for television broadcasting and transmitters, as well as members of committees charged with advising governments and official bodies as regards the choice of a colour television system for their respective countries. Chapter 9 will again interest those connected with television broadcasting, but here work connected with electronic masking is described and this may well be of interest to members of the photographic industry.

Chapter 10 will be a source of constant reference for engineers dealing directly with colour television problems, especially in connexion with standardization and use of appropriate terminology.

Appendix 1 is intended as a description of National Television System Committee colour television in non-technical terms and might well be read by those who have administrative rather than technical duties to perform in connexion with colour television. Appendix 2 contains, in abbreviated form, some of the information to be found in Chapter 2.

This book will be used primarily as a work of reference by engineers directly concerned with colour television. It may also be read by students of the subject, but in this case it is recommended that serious study of the book should be preceded by the reading of a suitable introduction to colour television. The book presents an excellent example of the application of fundamental physical principles to a practical problem and therefore, although principally a book for engineers, it may well find favour among physicists.

The author, Donald G. Fink, was for many years editor of the well-known American journal *Electronics* and is at present a member of the board of directors of the Institute of Radio Engineers in the post of editor. In his capacities as editor of the Proceedings of the first National Television System Committee (1940–41), vice-chairman of the second Committee (1950–52), chairman of Panel 12 (Colour System Analysis), and director of research of the Philco Corporation, he has acquired a very extensive knowledge of both monochrome and colour television, and is undoubtedly well qualified to produce this authorized compendium of the eighteen volumes produced by the second National Television System Committee (1950–53).

R. D. A. MAURICE

THE WEST INDIAN FAMILY

The Negro Family in British Guiana

Family Structure and Social Status in the Villages. By Dr. Raymond T. Smith. (International Library of Sociology and Social Reconstruction.) Pp. xvi+282+8 plates. (London: Routledge and Kegan Paul, Ltd.; New York: Grove Press, Inc., in association with the Institute of Social and Economic Research, University College of the West Indies, Jamaica, 1956.) 28*s*. net.

THE Caribbean region has been neglected by British anthropologists, partly for financial reasons and partly because of a legitimate concentration of interest on the study of non-European societies with a distinctive culture of their own. Interest in the region was awakened largely through the social policy introduced at the end of the Second World War, and public interest in the structure of the family is largely concerned with its relevance for such policy. Census figures have revealed that, in the poorer strata of the Negro population, a high proportion of children are born out of wedlock and a considerable number of conjugal unions are not legally sanctioned. They have been held to reinforce the middle-class myth of Negro immorality and promiscuity, and historical explanations of these alleged characteristics have been sought both in the values and modes of behaviour which became customary under slavery and in those which the Negroes brought with them from Africa.

Dr. R. T. Smith begins by challenging the initial assumption. From his intensive study of three Guianese villages, he concludes that there is no significant difference, in terms of the obligations recognized between the partners and towards their children, between marriage and the extra-legal domestic unions which he calls 'common-law marriage'. 'Common-law marriage' is simply the standard pattern for the lower class. A 'common-law wife' has herself no legal claims on her consort; but he is legally liable for the support of his children as a

husband is. Though the point would not affect his main argument, it might be interesting to know how far maintenance orders are in fact sought and enforced; Dr. Smith writes almost as if he was asserting that the courts provide a watertight system. Of course marriage, as the middle- and upper-class pattern, carries with it associations of higher status; but for that very reason it is not sought after by everyone. Persons who are seeking to raise their status will marry, others will not do so although they could well afford the expense of the celebration and the generally higher standard of living popularly associated with a married household.

In addition to producing the first fully documented study of the Negro family in the Caribbean, Dr. Smith has made some valuable contributions to general theory. He is the first explicitly to tackle the problem which must constantly arise now that anthropologists are transferring their attention from social units which can be treated as total systems to localities the boundaries of which are geographical rather than social. The Guianese village is wholly dependent politically and economically on the wider system of which it forms a part, and, what is more significant, the characteristic features of household and family are explicable only in terms of the place of the village population in the total structure. Thus the problem itself dictates how far the investigator must go outside the geographical boundaries of the sub-system selected for study.

Dr. Smith decisively rejects explanations in terms of the cultural background—that is, in effect, of history—though he recognizes that the synchronic study must cover the period of time necessary for household or family to pass through its full three-generation cycle of development. Space does not permit discussion of all the original ideas in this stimulating book.

L. P. Mair

PREVENTIVE PSYCHIATRY

Emotional Problems of Early Childhood

Edited by Prof. Gerald Caplan. Pp. xiv+544. (London: Tavistock Publications, Ltd., 1955.) 42*s*. net.

THIS book is the result of a symposium under the auspices of the International Institute of Child Psychiatry. Its theme is "The Child under Six", and its main headings are: psychosis in early childhood; problems of preventive psychiatry; the relation of physical and emotional factors; and problems of mother–child separation and hospitalization. A representative selection of twelve case-histories deals in great detail with the various aspects of diagnosis, treatment and prevention, each case being followed by a discussion by experts on the particular problems involved. Contributors and members of the discussion groups were drawn from different countries; but the majority came from the United States. In addition, there are reports on relevant research in progress in which the fundamental concepts, general principles and methodological problems arising from the material are discussed.

The book makes absorbing reading, whether it is the case of the mother who, following her husband's suicide, began to identify her fifteen-months old son with his dead father, causing severe disturbance in the child's development; whether it is the one of pseudo-deafness and retardation in a child who was abandoned by his mother at two months and was moved fourteen times before he was two; that of a four-year old of 'atypical development' who spoke his own language and frightened his parents by acting and gesticulating in an unusual way; or that of a mother whose child would not eat.

Case-histories, interviews and clinical observations afford a glimpse into the complicated nature of emotional problems in the very young child and their ramifications involving the family and the wider environment. They also reveal the difficulties of dealing with these problems in a constructive and planned way by teams of psychiatrists, psychologists and social workers as well as by the numerous social agencies; any of these may be the prime mover in a particular case.

The editor has more or less rewritten the different contributions, and the book reads as a coherent whole.

Apart from its intrinsic value, this work may teach us several lessons. For one thing, it demonstrates the fact that research in child psychiatry and clinical psychology must be based on the thoroughly investigated and well-authenticated individual case, presented in its broadest setting and in minute detail. The emphasis will have to be on description for a long time to come, with theoretical conclusions drawn tentatively, without attempting to generalize. For another, it shows the importance of closest co-operation within the team at all stages as well as of a fair degree of elasticity as to who should direct the case. Rigid rules (such as that the psychiatrist should invariably be in charge; or that mother and child should not be seen together or by the same person)—still prevalent in many child-guidance clinics—seem a disadvantage while our knowledge and experience in this field is still limited and inconclusive.

Both child psychiatry and child psychology emphasize the importance of early childhood experiences for later development; and it is perhaps in the field of the preventive mental health service that we can benefit most in considering the conclusions of this book. Preventive health services in child welfare have made great progress since the Second World War. Expectant mothers and new-born babies get all the physical care medical science regards as essential and beneficial. All stages of feeding, cleanliness, teething, weaning, etc., are carefully prepared and watched over by doctors, clinics and nurses. But no comparable measures are taken in the province of mental development. It is left to the child-guidance clinics to diagnose and treat emotional disturbances at a time when they are already well established and have become, as it were, part of the child's mental make-up. Although there is a growing tendency to refer children under school age to clinics, this is usually done when the symptoms have become too troublesome for the family. The logical course of development would be to introduce certain psychological observations in routine interviews at child-welfare clinics, in pediatric interviews and nursing practice, and to follow up any signs suggesting undue retardation or a potential source of disturbance. The work of Gesell, Ruth Griffiths, and others, proves that this is practicable; and the number of known instances of diagnoses of, say, mental defect when, in fact, they were cases of early schizophrenia, or retardation due to neglect, rejection or separation in early childhood, should make it seem highly desirable.

This is a book that will give ample food for thought to both specialist and layman.

Martha Vidor

RECONSTITUTION OF TOBACCO MOSAIC VIRUS COMPONENTS

By Prof. BARRY COMMONER, JAMES A. LIPPINCOTT, GEORGIA B. SHEARER, ELLEN E. RICHMAN and JIA-HSI WU

Henry Shaw School of Botany, Washington University, St. Louis, Missouri

CHEMICAL explanations of genetic activity call for correlations between the biological activities and specific chemical attributes of a genetic agent. This requires that the components responsible for an agent's several biological activities be separated from each other and from inactive material, and presupposes that the active components will withstand such treatment without undue loss of genetic competence.

In 1947 Schramm reported the first efforts to obtain information of this type from experiments with tobacco mosaic virus. In a series of fifteen reconstitution experiments with mixtures of previously separated tobacco mosaic virus protein and nucleic acid, he experienced two instances of apparently successful recovery of infectivity. However, because of the slight effects obtained and the fact that most experiments were not successful, Schramm declined to consider the phenomenon established[1]. Following subsequent improvements by Schramm of the method of releasing tobacco mosaic virus protein from the virus[2], Fraenkel-Conrat and Williams[3] and Lippincott and Commoner[4] reported the results of independent investigations which led to consistent success in reactivating mixtures of virus ribonucleic acid and Schramm's 'protein a' (prepared by mild alkaline treatment of tobacco mosaic virus). In both cases, the reactivated material was only of marginal infectivity, being no more than one-hundredth as active as authentic tobacco mosaic virus. This fact appeared to preclude extensive use of the reactivation phenomenon as a means of determining the biochemical basis of the genetic activity of the virus. This article describes the partial solution of this problem, and some experiments concerning the relationship between the composition and biological activity of nucleoproteins artificially reconstituted from tobacco mosaic virus protein and nucleic acid.

Tobacco mosaic virus is a hollow rod. Small protein units are arrayed in a flat spiral; nucleic acid strands are in a concentric zone in the rod[5]. When the virus nucleoprotein is treated at *p*H 10·5 for about 3 hr. in the cold the protein sub-units become dissociated, and may be recovered as separate low molecular weight entities. This preparation may be freed of residual virus by ultracentrifugation and of dissociated ribonucleic acid by adsorbing the latter on a column of modified cellulose ('Ecteola *SF*')[6]. Virus ribonucleic acid may be prepared by the method of Cohen and Stanley[7], and purified by ultracentrifugation and alcohol precipitation.

Low molecular weight protein isolated from tobacco mosaic virus in the manner just described will polymerize (at *p*H 6, or in 28 per cent ammonium sulphate) to form hollow rods resembling those of ordinary tobacco mosaic virus in size and shape. Such nucleic acid-free rods, like the original low molecular weight protein, are not infectious. Schramm finds that when tobacco mosaic virus is partially degraded with alkali, some of the product consists of virus rods containing intact threads of nucleic acid, which retain an interrupted coat of protein at intervals along their length[2]. Such material appears to be infectious, though weakly so. When these particles are treated with ribonuclease, the enzyme is able to attack the denuded portion of the nucleic acid and the rod breaks and becomes devoid of infectivity[8].

This information suggests some possible causes for the low level of infectivity exhibited by the products of the reconstitution procedures employed in the initial investigations by Fraenkel-Conrat and Williams, and by Lippincott and Commoner. From what is known about the behaviour of tobacco mosaic virus protein and ribonucleic acid, the reconstitution process may be expected to produce: (*a*) polymerized protein lacking nucleic acid, (*b*) nucleoprotein comprising nucleic acid completely coated with protein, and (*c*) nucleoprotein particles in which the protein coat contains small faults. All three types of products may be approximately equivalent in sedimentation behaviour and, without special degradation procedures, will appear to be identical in the electron microscope. However, of these components, only the particles with entire protein coats may be expected to be equivalent to tobacco mosaic virus in infectivity.

With these considerations in mind, an effort has been made to improve the completeness and specificity of the interaction between virus protein and nucleic acid in reconstitution experiments and thereby to enhance the infectivity of the product. Consideration of the probable reaction kinetics suggests the following conditions for optimum formation of active nucleoprotein from tobacco mosaic virus protein and ribonucleic acid.

(1) Reaction mixtures should contain relatively low concentrations of nucleic acid and protein. Joint polymerization is linearly related to reactant concentrations, while self-aggregation of protein (and of nucleic acid) depends on a higher power of the concentration.

(2) To enhance the thermodynamic activity of the reactants, they should be relatively insoluble in the solvent chosen for the reaction mixture.

(3) To avoid gaps in the protein coat of the nucleoprotein polymer, accretion of protein units around the ribonucleic acid should ideally proceed from a single starting point rather than from multiple protein 'seeds'. This requires that reaction mixtures contain relatively low molar ratios of protein to nucleic acid. Nevertheless, the molar ratio of protein : nucleic acid in the virus nucleoprotein is about 2,000 : 1 (the nucleic acid being considered a single molecule) and the reactants need to enter into the product in this proportion.

To reconcile these conflicting demands, protein is added in small amounts over an extended period of time to a relatively low concentration of virus ribonucleic acid dissolved in a medium (28 per cent or

Table 1. Infectivity of Nucleoprotein reconstituted from Tobacco Mosaic Virus (TMV) Protein and Nucleic Acid by Various Methods

Experiment No.	Reactants: Protein μgm.	Reactants: Nucleic acid μgm.	Conditions: Solvent	Conditions: Final volume ml.	Conditions: Protein additione	Nucleoprotein recovered μgm.	Total No. of lesionsd	Equivalent infectivity; μgm. TMV	Specific infectivity; per cent of TMV standardf
1 *A*	4,500	70	*p*H 6 buffer	7	gradual	526	137	3	0·6
1 *B*	4,500	70	28% $(NH_4)_2SO_4$	105	gradual	1,166	3,182	64	5·5
1 Controla	4,500	—	—	—	—	—	3	—	—
1 Control	—	70	—	—	—	—	0	—	—
2 *A*	4,980	89	28% $(NH_4)_2SO_4$	80	immediate	1,183	8,172	53	4·5
2 *B*	4,980	89	28% $(NH_4)_2SO_4$	105	gradual	781	7,643	50	6·3
2 Control	4,980	—	—	—	—	—	19	—	—
2 Control	—	89	—	—	—	—	7	—	—
3 *A*	4,230	76	28% $(NH_4)_2SO_4$	80	immediate	1,200	5,846	53	4·4
3 *B*	4,230	76	28% $(NH_4)_2SO_4$	105	gradual	918	7,590	65	7·1
3 *C*	4,230	76	28% $(NH_4)_2SO_4$b	75	gradual	933	9,933	85	9·1
3 Control	4,230	—	—	—	—	—	44	—	—
3 Control	—	76	—	—	—	—	8	—	—

The results of three separate reconstitution experiments. Reactants were prepared as described in the text, the nucleic acid being used immediately after being centrifuged out of 66 per cent ethanol. Nucleic acid was dissolved in the indicated solvent, and protein in aqueous solution was added either immediately or gradually. Simultaneously, sufficient ammonium sulphate was added to maintain the indicated concentration. The temperature was 4° C. throughout. (*a*) Controls were treated in the same way as the mixtures, the material yielded being finally inoculated on leaves of *N. glutinosa*. (*b*) In experiment 3 *C* nucleic acid was dissolved in 62 per cent ammonium sulphate, the concentration of which was gradually reduced to 28 per cent as the protein solution was added. (*c*) Gradual addition of protein was accomplished in eleven portions over a 3-hr. period, except in experiment 1 *A*, in which a 24-hr. period was employed. (*d*) All preparations inoculated on twenty leaves of *N. glutinosa*. In experiments 3 *A*, 3 *B* and 3 *C* only 1/5 of the nucleoprotein was inoculated. In all other cases, all the recovered nucleoprotein was inoculated. (*e*) Equivalent infectivity is determined from the quotient: (lesions from sample/lesions from tobacco mosaic virus standard) × amount of tobacco mosaic virus standard. Tobacco mosaic virus standards (4 μgm.), inoculated on twenty leaves of *N. glutinosa*, yielded 249 lesions in Exp. 1, 774 lesions in Exp. 2, 2,932 lesions in Exp. 3. In all cases, standards and experimental samples were inoculated on randomized groups of the same batch of detached leaves which were maintained in water at 24° C. and constant illumination during lesion formation. (*f*) Specific infectivity (as percentage) is determined from quotient: (equivalent infectivity of sample/amount of nucleoprotein in sample) × 100

more ammonium sulphate) in which the protein is relatively insoluble.

Table 1 compares the results of a reconstitution method based on these considerations with the infectivity of reconstituted nucleoprotein prepared by the earlier technique. Whereas the earlier procedure (experiment 1 *A* in Table 1) yields nucleoprotein less than 1/100 as infectious as actual tobacco mosaic virus, the newer method yields a product which may approach one-tenth of the infectivity of tobacco mosaic virus. These experiments also provide data which firmly establish the authenticity of the reconstitution process: the number of lesions yielded by reconstituted material is about a thousand times greater than the number produced by the uncombined starting materials.

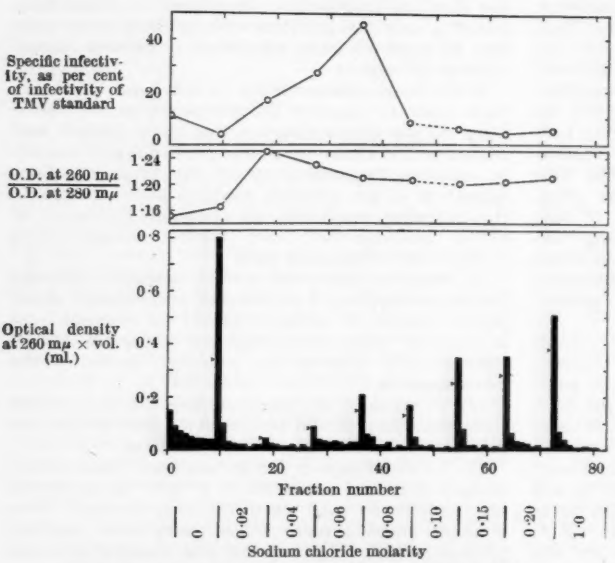

Fig. 1. Fractionation of 6·77 mgm. of reconstituted nucleoprotein by elution from a column containing 182 mgm. of 'Ecteola *SF*'. Eighty-six per cent of the original nucleoprotein was recovered. Elution was accomplished with successively higher concentrations of sodium chloride in 0·01 *M* phosphate buffer, *p*H 7, collected in 2 ml. fractions. The initial 2 ml. fraction obtained after each solvent change was ultracentrifuged to precipitate high-molecular weight nucleoprotein, the amounts recovered being indicated by the arrows. The uppermost and centre curves show, respectively, the specific infectivity (relative to the lesion count given by a standard tobacco mosaic virus solution on opposite halves of *N. glutinosa* leaves), and the ratio of optical densities at 260 mμ and 280 mμ of the nucleoprotein recovered from these initial fractions. The specific infectivity of the original nucleoprotein was 6 per cent of the tobacco mosaic virus standard

The preceding results imply that the gross product of a reconstitution experiment is a heterogeneous population of nucleoprotein entities which differ with respect to nucleic acid content, the completeness of their protein coats and infectivity. This suggests that a fractionation process based on the relative accessibility of the ribonucleic acid of the reconstituted particles might also serve to concentrate the most infectious components. Fig. 1 shows the results obtained when reconstituted material with an original specific infectivity of 6 per cent is adsorbed on an 'Ecteola *SF*' column, and fractions are eluted by successive additions of increasing concentrations of sodium chloride in 0·01 *M* *p*H 7 phosphate buffer. The nine fractions recovered from the column differ in stability, in relative nucleic acid content (as shown by the ratios of optical densities at 280 and 260 mμ), and in infectivity. As expected, the bulk of the material is very low in infectivity. The relatively small fractions eluted with 0·04–0·10 *M* sodium chloride contain most of the infectivity of the original material. The 0·08 *M* sodium chloride eluate comprises nucleoprotein which is about 45 per cent as infectious as ordinary tobacco mosaic virus.

A fractionation comparable to that just described has also been carried

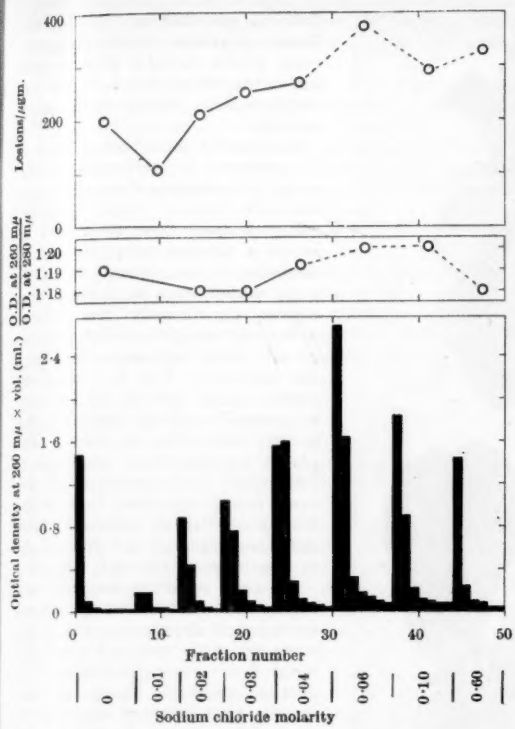

Fig. 2. Fractionation of 8 mgm. of ordinary tobacco mosaic virus on a column containing 500 mgm. of 'Ecteola *SF*'. Elution procedures were as described in the legend for Fig. 1. The fractions collected with each solvent were pooled and the high molecular weight material collected by ultracentrifugation. The two upper curves refer to this material. Total recovery was 96·5 per cent of the original virus

out with the original stock preparation of natural tobacco mosaic virus. The results, which are summarized in Fig. 2, show that ordinary tobacco mosaic virus is heterogeneous with respect to elution behaviour, infectivity and nucleic acid content (ratio of 260 mμ : 280 mμ optical densities).

Comparison of Figs. 1 and 2 shows that the composition of the nucleoprotein populations that comprise natural tobacco mosaic virus and the reconstituted material differ significantly. The major fractions in ordinary tobacco mosaic virus are eluted by 0·04–0·10 *M* sodium chloride; but these fractions represent minimal components in reconstituted nucleoprotein. In both cases, the most infectious nucleoprotein is found in the fractions eluted by 0·06–0·08 *M* sodium chloride. The remaining fractions contribute rather little to the total infectivity of reconstituted nucleoprotein, but in tobacco mosaic virus these fractions are only moderately less infectious than the major component.

This heterogeneity is reflected in the biological properties of reconstituted preparations. An unusual number of aberrant symptoms have been observed in *Nicotiana tabacum* plants systemically infected with single lesions derived from reconstituted nucleoprotein. These include: (*a*) 'strap leaves', leaves reduced to midribs only; (*b*) bright yellow mosaic; (*c*) pale green mosaic followed by necrosis in the mosaic areas; (*d*) circular necrotic lesions on the inoculated leaf. None of these symptoms was found among a comparable number of plants from the same culture generation inoculated with single lesions derived from ordinary tobacco mosaic virus.

These observations suggest that the manipulations incident to the isolation of tobacco mosaic virus protein and nucleic acid and to the reconstitution process may alter the genetic competence of the virus components. Results recently reported by Gierer and Schramm[9] indicate that the biological activity of the virus is at least in part due to its ribonucleic acid. It has been shown that the ribonucleic acid isolated from tobacco mosaic virus is partially dissociated into fragments of variable size, which can be fractionated by elution from 'Ecteola' columns[10]. It is to be expected, therefore, that the nucleic acid which is incorporated into nucleoprotein particles during the reconstitution process may represent fragments of virus ribonucleic acid or various combinations of such fragments, as well as substantially intact virus nucleic acid.

Accordingly, an effort has been made to fractionate the components which occur in preparations of tobacco mosaic virus nucleic acid, and to incorporate them separately into reconstituted nucleoproteins. Ribonucleic acid was prepared in the usual manner and fractionated on an 'Ecteola *SF*' column according to the method of Bradley and Rich[10]. Three fractions, obtained by this procedure, were concentrated by precipitation in 66 per cent ethanol, redissolved in water and polymerized with tobacco

Table 2. Infectivity of Nucleoprotein reconstituted from Tobacco Mosaic Virus (TMV) Protein and Fractions of TMV Nucleic Acid

Nucleic acid fraction	Reactants[a]		Nucleoprotein recovered μgm.	Nucleoprotein tested μgm.	Total No. of lesions[c]	Equivalent infectivity: μgm. TMV[d]	Specific infectivity: per cent of TMV standard[e]
	Protein μgm.	Nucleic acid μgm.					
(1) Entire, unfractionated	8,580	94	935	750	833	4·75	0·51
(2) 0–0·15 *M* NaCl eluate	13,000	223	1,610	1,290	75	0·44	0·03
(3) 0·15–0·25 *M* NaCl eluate	3,250	130	270	216	28	0·16	0·06
(4) 0·25–0·30 *M* NaCl eluate	1,742	49	105	84	31	0·37	0·38
(5) None (control)[b]	8,580	—	—	—	0	—	—
(6) Unfractionated (control)	—	94	—	—	2	—	—

The nucleic acid (1,543 μgm.), after being precipitated in 66 per cent ethanol, was adsorbed on a column containing 0·5 gm. of 'Ecteola *SF*' and eluted with increasingly stronger sodium chloride solutions in 0·01 *M* phosphate buffer, *p*H 7. About 31 per cent of the nucleic acid was recovered in the sodium chloride eluates, the remainder being removable from the column with alkali. The fractionation required about 8 hr. The unfractionated aliquot was held for this time before reaction with protein; this probably accounts for the relatively low infectivity of the product as compared with the results reported in Table 1. (*a*) Nucleic acid was dissolved in sufficient 28 per cent ammonium sulphate to yield solutions of approximately 1 μgm. of ribonucleic acid per ml. Protein was added gradually over a 3-hr. period. (*b*) Controls were treated in the same way as the mixtures, and the material yielded finally inoculated on *N. glutinosa* leaves. (*c*) All preparations tested on twenty randomized leaves of *N. glutinosa*, except preparation (4), which was tested on ten leaves. (*d*) Equivalent infectivity is determined from the quotient: (lesions from sample/lesions from tobacco mosaic virus standard) × amount of tobacco mosaic virus in standard. In this experiment, 2 μgm. of standard tobacco mosaic virus inoculated on twenty leaves of *N. glutinosa* produced 438 lesions. Other infectivity procedures were as described in Table 1. (*e*) Specific infectivity (as percentage) is determined from the quotient: (equivalent infectivity of sample/amount of nucleoprotein in sample) × 100

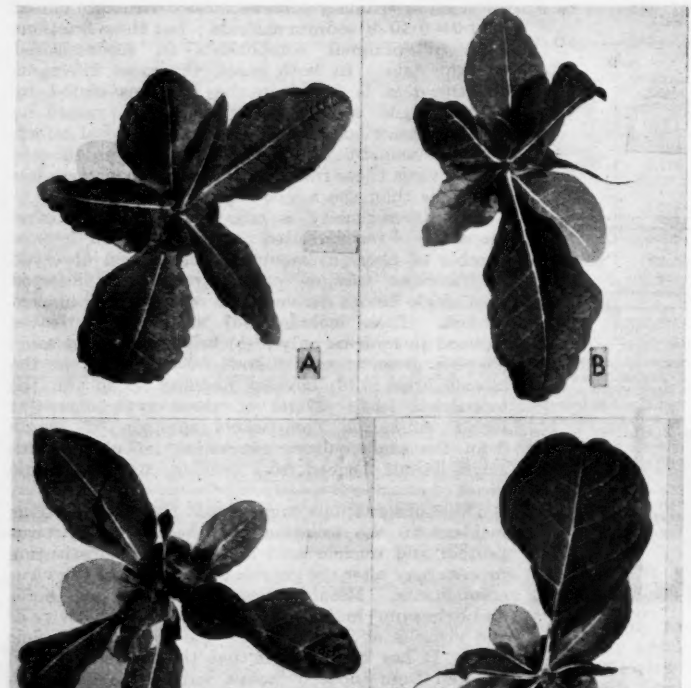

Fig. 3. The effects of infection with reconstituted nucleoprotein prepared from a fraction of tobacco mosaic virus nucleic acid eluted from an 'Ecteola *SF*' column between 0·15 and 0·50 *M* sodium chloride. The photograph shows four plants of the same culture generation two months after being inoculated, respectively, with a single lesion derived from ordinary tobacco mosaic virus (*A*), and with three separate lesions produced by the reconstituted nucleoprotein (*B*, *C*, *D*). Photographs *E* and *F* represent leaves of comparable serial position removed from plants *A* (tobacco mosaic virus) and *D* (reconstituted nucleoprotein), respectively. In *E* and *F*, the most basal leaf is in the upper left-hand corner of the photograph

mosaic virus protein by the method already described. The results are shown in Table 2. In each case the reconstitution process yielded a high molecular weight nucleoprotein (absorption maxima at 260 mμ; minima at 250 mμ; ratios of optical densities at 260 mμ and 280 mμ, 1·17–1·30). These products exhibited infectivity, which varied in level according to the ribonucleic acid fraction employed to form the nucleoprotein.

Lesions produced on leaves of *N. glutinosa* by nucleoprotein derived from various ribonucleic acid fractions eluted from 'Ecteola' columns have been employed to infect a number of plants of *N. tabacum*. Among these plants are some which show symptoms that depart significantly from those ordinarily associated with tobacco mosaic virus infection. Examples are shown in Fig. 3. In these plants apical growth is severely suppressed, and leaf blades become greatly reduced or are absent. The plants contain large amounts of infectious nucleoprotein, which upon being inoculated into White Burley or Turkish tobacco plants induces symptoms like those found in the original infected plants.

In two separate experiments, highly aberrant floral symptoms were found among the plants inoculated with single lesions derived from reconstituted nucleoprotein produced with a ribonucleic acid fraction eluted from 'Eeteola' columns between 0·25 and 0·30 *M* sodium chloride. The infected flowers show a scattered mottling in pigmentation rather than the sharp-edged 'breaks' characteristic of flowers infected with ordinary tobacco mosaic virus, and are remarkably transformed in shape. Uniform and symmetrical suppression of lateral extension of the petals gives rise to a deeply cleft, fringed corolla. Although plants infected with ordinary tobacco mosaic virus sometimes produce flowers with irregularly distorted corollas[11], symmetrical transformations do not occur.

The foregoing results show that reconstitution of tobacco mosaic virus protein and nucleic acid provides experimental opportunities suitable for investigations of the chemistry of genetic competence. The virus nucleic acid, which is at least in part responsible for the genetic specificity of the virus, will withstand isolation procedures without losing its activity. The reconstitution process, while yielding heterogeneous nucleoprotein, is amenable to procedures which enhance the specificity of protein–nucleic acid interaction. By these means and by suitable fractionations it is possible to obtain reconstituted nucleoprotein which has an inherent infectivity approaching that of natural tobacco mosaic virus. Thus, the

process appears to be capable of yielding preparations which are sufficiently infectious to enable valid correlations between composition and biological activity.

There is evidence that both the physical and genetic integrity of the virus nucleic acid is disrupted during the process of extraction. As a result, at least some of the nucleoprotein reconstituted from virus nucleic acid and from isolated nucleic acid fractions appears to be genetically different from the original virus.

With further attention to these effects, the reconstitution phenomenon may provide a means for correlating the biological attributes of the virus with the composition of its component parts.

We wish to acknowledge the valuable suggestions made by Dr. Otto Redlich, of the Shell Development Co., in connexion with the kinetics of the reconstitution process. The work reported in this paper was aided by a grant from the National Foundation for Infantile Paralysis, and by a grant from the Rockefeller Foundation.

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THE STRUCTURE AND GROWTH OF WOOL

A SESSION of Section D (Zoology) of the British Association meeting at Sheffield was devoted to "The Structure and Growth of Wool and other Animal Fibres"—a symposium that might well have been held jointly with Section M (Agriculture). The subjects of the papers presented ranged from "Fleece Growth", through the detailed consideration of various aspects of individual fibre growth, to the chemical and physical structure of the wool fibre.

Dr. A. B. Wildman (Wool Industries Research Association), whose opening paper, "Fleece Growth", was read by Mr. H. B. Carter, stated that there is developing in Great Britain an increased awareness among sheep farmers of the importance of supporting wool biological research, and applying its results. He said that, briefly, the objectives of research into the biology of wool are to provide knowledge whereby the quality and quantity of any particular type of fleece may be improved. Progress can only be made if wool improvement is clearly defined. This depends on the breed of sheep, district, and flock being considered. For example, in one flock wool improvement may be defined as "the increase of average fleece weight, with maintenance of reasonable fleece uniformity in fibre thickness and other important fleece characteristics". In addition, careful thought must be given to the way such improvement may be realized in a reasonable time.

If, for example, the objective is to raise average fleece weight, then the heritability of fleece weight in the breed in question must be considered. If fleece weight is strongly inherited, then selecting for high fleece weight would give an improvement reasonably quickly. But if this character is weakly inherited, only breeding animals must be selected, particularly the rams, whose progeny have given high fleece weights. Research such as this, based on carefully controlled mating and accurate observation of fleeces at various ages, might be termed 'breeding research'. Dr. Wildman said that there is, however, a second broad category of biological wool investigation, namely, 'fleece or fibre growth research', and he went on to indicate some of the facts about fleece development. The first wool follicles to be formed in the fœtus are known as primary follicles; those formed later are secondaries. The primaries are characterized by the 'possession' of a sweat gland in addition to the sebaceous glands found associated with both the primary and secondary follicles. The primary follicles are all developed before birth, and form follicle groups with their more numerous associated secondaries. Although many secondary follicles are developed before birth, they continue to be developed for some time afterwards, at any rate in British breeds. It was the development of secondary follicles that Dr. Wildman particularly considered, because the densest fleeces often have a higher proportion of secondary follicles, that is, a greater secondary to primary (S/P) follicle ratio. He outlined the results of investigations designed to show whether environment affects the number of secondary follicles formed, that is, the S/P ratio, bearing in mind that there are genetic differences in mature S/P ratio between breeds and within breeds.

Schinckel[1], working with Merinos in Australia, found that single lambs had a higher S/P ratio at birth than twin lambs. Ryder[2] found a positive correlation between S/P ratio at birth and body weight at birth in Cheviot lambs with body weights ranging from 8 to 14 lb.; and Dr. Wildman said he had found a similar relation between S/P ratio at birth and body weight at birth in Romney Marsh lambs with birth weights ranging from $5\frac{1}{2}$ to 15 lb. Thus lambs that suffer nutritional penalty during fœtal life tend to have a lower S/P ratio at birth. The next question was: Are there any influences between birth and weaning time which affect mature S/P ratio? In the Cheviots it was found that mature S/P ratio is correlated with body weight at birth, and Dr. Wildman showed a scatter diagram illustrating a lack of positive correlation between gain in S/P ratio and gain in body weight from birth to weaning. With the Romneys, however, a scatter diagram of S/P ratio at 90 days plotted against birth weight showed a slight trend towards a positive correlation with lambs over $10\frac{1}{2}$ lb., but none with lambs weighing less than this; and when gain in S/P ratio was plotted against gain in body weight, a slightly positive relation was found. Breeds therefore differ in this respect, and Dr. Wildman thought that part at least of the explanation of this difference between the Romney and the Cheviot may be due

to a longer developmental period of secondaries in the Romney. In the Cheviot the follicle population may mature early, and had probably reached the upper genetic limit for the breed before the total number of follicles could be affected by small environmental and nutritional conditions.

Dr. M. L. Ryder (Wool Industries Research Association) then presented a paper entitled "The Blood Supply to the Skin and Wool Follicles of Sheep". He said that there were two main reasons for making a study of the blood supply to the skin. First, it was possible that some explanation for regional variations in the fleece might be found in the blood supply to the skin. The term regional variation is used for describing the difference, for example, between the fine wool of the shoulder and the coarse wool grown on the hinder parts of a sheep. Such variation is hereditary, and in fact no explanation for it was found in the blood supply. Secondly, as more and more experiments showed the extent to which the diet of the sheep can cause the wool to vary, it became important to know the way in which nutrients reach the wool follicle. Such variation was indicated in Dr. Wildman's paper; but one perhaps more obvious difference appears as change in diameter along the length of the fibre.

The first stage of the investigation was to dissect lambs in order to trace the main vessels leading to the skin, which was found to be supplied by numerous small arteries evenly distributed over the body. These vessels enter a network which can be seen on the under surface of a skin after removal. The density of this net was not found to vary greatly in different body regions or between breeds of sheep. Thus, the way in which blood reaches the skin was discovered; but no anatomical differences were found in the blood supply that would account for differences in fleece growth, either over the body or between breeds. This vessel network on the under surface of the skin is the dermal network lying at the base of the dermis.

There are two more networks within the skin and parallel to the skin surface. These are the mid-dermal vessels, lying about one-third of the depth of the skin below the surface, and the outermost net beneath the epidermis. The wool follicles are supplied from the two inner nets, the dermal and mid-dermal vessels.

The immediate supply to the follicle consists of a basket-like net of capillary vessels surrounding the lower third of the follicle, and others which enter the papilla beneath the growing point of the fibre. Blood seems to rise to the peak of the papilla first, and the larger the papilla the more vessels it contains. The surrounding network terminates at the level at which the fibre has become keratinized, and there is a part on one side of the follicle, immediately above the bulb, where the vessels are denser than anywhere else. This may have some association with the bilateral structure of the fibre, which in turn is thought to be connected with the crimp of wool.

Dr. L. Auber (Wool Industries Research Association) followed with a paper on the "Comparison of Development of Fibres and Related Structures". Dr. Auber stated that fibrillary origin is common to all horny structures produced by the epidermis of 'higher vertebrates'. The simplest structure is stratum corneum, from which flat reptilian scales appear to be the immediate derivatives. Cellular elongation and parallel orientation of fibrillary cell-contents occur in certain reptilian scales, the cortex of bird feathers, and mammalian fibres (wool and all types of hair). Both feather barbs and fibres tend to develop axial strands known as medullæ, which are characterized by turgidity during their differentiation and by vacuolization in their fully formed state. On fibres, and usually also on feather barbs, flattened layers of surface cells are found; in fibres they constitute the well-known overlapping cuticular scales.

Feathers and fibres have apparently originated independently although the function of both is thermal insulation. Histochemically, however, they have much in common; this is revealed by their staining reactions. The cortex in both structures tends to pass through successive phases of affinity for acid, basic and nitro dyes, but the medulla stains only with acid dyes. In fibres the progress of differentiation of the cortex varies between species, whereas the progress in feathers follows the general development of the barb from the obverse to the reverse. In wool the keratinization starts at one side, and the progress across the fibre is termed segmental, whereas in straight fibres the progress is periphero-axial, proceeding concentrically. The so-called shield hairs of many aquatic mammals show deviations from periphero-axial progress. In the beaver, for example, the keratinization starts on one side, but does not proceed directly across the fibre: it first spreads around the surface of the cortex.

Mr. H. B. Carter (Agricultural Research Council's Animal Breeding Research Organization) considered the fleece again with a paper entitled "The Determinants of Fleece Structure in the Merino and its Crosses". He said that among several hundred breeds of sheep in the world, the Merino group is perhaps the most important. This group constitutes about one-fifth of the estimated world sheep population and produces about one-third of the world's natural wool supply. During the past two centuries no other breed or group of breeds has been so extensively used for crossing. The distinctive basis of the Merino's fleece structure is a dense follicle population in which the follicle groups tend to be larger than those of any other breed. These large follicle groups are associated with high S/P follicle ratios the values of which range from 5 to 45 secondaries per primary follicle. In all other breeds not obviously related to the Merino the extreme range of S/P ratio is roughly from 2/1 to 10/1. Cross-breeding with the Merino, therefore, tends more than anything else to increase the fibre population of the fleece provided Merinos with large follicle groups are used.

In cross-breeding, the Merino tends to modify fleece structure by reducing wool fibre thickness, fibre length, medulation, and the output of water-soluble skin secretions even when these characteristics are strongly expressed in the breeds with which it is crossed. Conversely, it tends to increase not only fibre population density but to enhance the expression of skin wrinkles and folds, and the output of sebaceous (mostly ether-soluble) skin secretions. All these characters in the cross-breds tend to have values intermediate between the parental breeds. Characters associated with the follicle group in the skin appear to have moderate to high heritability values and hence may respond well to direct selection. The biological origin of the prototype Merino is still obscure, and Mr. Carter stressed the importance of solving in genetic terms the problem of the origin of the very large follicle group which seems to be a special feature of Merino types. Its solution could

help greatly in clarifying the aims and practice of sheep breeding for the improvement of wool production.

Dr. F. Happey (Technical College, Bradford) took the audience abruptly from sheep to molecules by presenting a paper entitled "The Fine Structure of the Protein Fibres". This dealt with physical studies of the structure of protein molecules. Dr. Happey said it is clear that any advances made in the elucidation of their complex nature have only been achieved by considering their aggregations in conjunction with those of other related long-chain molecules. In polypeptides the specific properties appear to depend upon the sequence of the amino-acids in the chain, and the folding of the molecule. It appears from X-ray diffraction pictures that there is structural similarity between synthetic and natural polypeptides.

When the stabilizing S—S link of wool has been broken by oxidation, about 90 per cent of the fibre can be dissolved in weak alkali, leaving an insoluble matrix. The soluble phase can be regenerated and the resulting filaments are usually in the alpha configuration. This appears to confirm the findings from synthetic polypeptides that the alpha form is not necessarily a product of specific biosynthesis[3]. The same physical methods have shown a web structure in the wall of the human intervertebral disk. Here the protein is made up of crossed sheets of collagen fibrils which form a cylindrical elastic membrane enclosing, ideally, a gelatinous matrix of collagen and polysaccharide to form a 'shock absorber'. In conclusion, Dr. Happey said that he had tried to show the breadth of the application of physico-chemical methods to fibrous materials. We are, however, still on the fringe of the biophysical problem of protein structure. The physicist, he said, is well aware of his limitations and needs to be constructively criticized by the biologist to ensure that he does not miss the fundamentals in a mass of classical biological data. Nevertheless, such collaboration is achieving progress in this vital study of the proteins.

M. L. RYDER

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RECENT ANTARCTIC RESEARCH

A LARGE audience attended the joint symposium on "Antarctic Research" held by Sections C (Geology) and E (Geography) of the British Association in the Firth Hall, University of Sheffield, on September 4.

Sir Raymond Priestley, who acted as chairman, emphasized three aspects of the progress of geological research in the Antarctic. First, he noted the extreme good fortune of the early expeditions, the bases and journeys of which were situated in those parts of the continent where many of the key horizons were accessible. In consequence, the outlines of Antarctic palæontology and palæoclimatology had been traced before 1915 and later exploration had little modified the conclusions deduced from these early discoveries.

Secondly, Sir Raymond noted the absence of important economic discoveries apart from the early finds of thin coals in the Permo-Carboniferous Beacon Sandstone of the Ross Dependency. He emphasized the necessity of luck in finding chance outcrops containing ore deposits, but ventured to predict that the exposures of the Basement Complex on the western shores of McMurdo Sound, which is the proposed site of the New Zealand base for the Trans-Antarctic Expedition, might prove to be the most promising locality for seeking metalliferous ore deposits.

Sir Raymond Priestley then emphasized the burden placed upon the field scientist by the routine commitments of expedition life. He noted the necessity for the geologist to travel many miles to examine outcrops at the end of a strenuous day's travelling; for the surveyor to lose sleep in order to obtain astronomical observations.

Sir Raymond's principal criticism of British expeditions during the past thirty years was their failure to provide a full-time and competent cook for each party. He noted the grave disadvantages which arose when a scientist was forced to interrupt his programme in order to take his share of the cooking. The present writer supports this criticism, having, in two years, spent twenty-eight weeks cooking at the expense of all other activities.

Sir Raymond emphasized the financial difficulty which nearly every expedition has faced in attempting to publish the results of its field-work. In contrast, he noted the establishment of the Falkland Islands Dependencies Survey Scientific Bureau in 1950 as a determined effort to integrate the different studies carried out by this Survey during the post-war decade.

Sir Raymond Priestley then introduced Dr. V. E. Fuchs, the leader of the 1955–58 Trans-Antarctic Expedition.

Dr. Fuchs emphasized that although the first voyage of the *Theron* had established the base known as 'Shackleton' in Vahsel Bay, the field party has so far accomplished little scientific work. Indeed, the loss of the chemicals for generating hydrogen when the sea-ice broke up during the autumn had been a grievous setback which would delay the radiosonde programme for a whole year.

He spoke at length about the proposed scientific programme and showed how this would dovetail with the prime object of the transcontinental journey. Dr. Fuchs noted the value of aircraft for reconnaisance, for depot-laying and as a safety factor in Antarctic travel, but emphasized the limited value of observations from aircraft without adequate ground control. The prime scientific aim of the mechanized trans-continental party will be the maintenance of continuous seismic and gravity traverses across the inland ice to measure the thickness of the ice and ascertain the underlying topography.

It is hoped that much of the more specialized glaciological and physiological research will be carried out at the 'Advance Base' which it is hoped may be established some three hundred miles south of Vahsel Bay. Precise plans will, however, depend upon the accessibility of the inland ice. The flights of the Auster aircraft from Vahsel Bay last summer

led to the discovery of an extensive mountain range about two hundred miles south of 'Shackleton'. Dr. Fuchs suggested that the possible continuity of this range with the mountains of Dronning Maud Land and its supposed extension towards Graham Land may considerably modify the plans of the Expedition. Although this difficult mountain terrain might be crossed by parties using dogs or man-hauling, this country might prove impassable to tracked vehicles. The presence of these mountains on the direct route southwards might necessitate a detour of several hundred miles.

Dr. Fuchs then showed a number of colour slides illustrating the voyage through the Weddell Sea and the establishment of the base at Vahsel Bay. Although he discussed some of the problems of navigation through heavy pack-ice, the writer suggests that Dr. Fuchs tended to minimize the difficulties of approaching Vahsel Bay. The *Theron* is only the fourth ship to reach the Filchner Ice Shelf, the annual variations of pack-ice in the Weddell Sea are still little known and the success of the Trans-Antarctic Expedition still depends primarily upon the ice conditions in the Weddell Sea next summer.

The third contribution to the symposium was made by Dr. R. J. Adie (Department of Geology, University of Birmingham), who read a paper entitled "Geological Research in Graham Land".

Dr. Adie briefly reviewed the state of knowledge about the geology of Graham Land before the field investigations of the Falkland Islands Dependencies Survey commenced in 1944. He showed a series of maps which demonstrated the extent of the researches of earlier expeditions and then showed a remarkably complete geological map resulting from the post-war journeys. Dr. Adie summarized, in turn, the characteristics of the various formations which have been studied. These include: (1) The Archaean Basement Complex of Marguerite Bay. (2) The Trinity Peninsula Series of north-east Graham Land, comprising greywacke facies sediments which suffered cataclastic deformation in pre-Jurassic times and thermal metamorphism around the Andean intrusions of early Tertiary age. (3) Mesozoic sedimentary rocks of north-east Graham Land and Alexander I Land which have yielded abundant fossils. These range in age between Middle Jurassic (Hope Bay) to Upper Cretaceous (James Ross Island). The Upper Jurassic–Lower Cretaceous conformable succession in Alexander I Land is contemporaneous with a period of igneous activity in Marguerite Bay. (4) Tertiary igneous rocks which are represented by the Andean granite-gabbro suite (constituting at least 90 per cent of the peninsula); this is considered to have an Early Tertiary age, followed by at least two lava and three volcanic phases in Miocene times.

Dr. Adie was able to demonstrate that the recent work of the Falkland Islands Dependencies Survey has further reinforced the belief of Suess that the Graham Land peninsula is linked with the Andean fold range by the Scotia Arc. Dr. Adie was unable to provide any new evidence to show the relationship of Graham Land with the rest of Antarctica.

Dr. Adie was followed by Dr. D. H. Maling (Department of Geography, University College of Swansea), with a paper entitled "Some Geographical Results of the work of the Falkland Islands Dependencies Survey".

Dr. Maling reviewed the work of the Survey since its inception as a small naval operation in 1944. By means of a series of diagrams he was able to show how the size and interests of the Survey had grown from two bases, manned by fourteen men in 1944, to ten bases with seventy-six men in 1956. He further showed that the total effort of the wintering parties represented 339 man-years and subdivided these figures to represent the work done in the different branches of research at the different bases. In particular, the routine work at the smaller bases received special emphasis.

Dr. Maling was able to show that the meteorological observations of the Survey were of prime importance because these had been made at every base throughout its occupation. There are now several bases where nine or more years of continuous observations have been maintained. The value of such climatic data is considerable for, with the exception of the long-established stations at Laurie Island, South Orkneys, and Grytviken, South Georgia, there were formerly no places in Antarctica where observations had been made for more than two consecutive years. To-day we have a clear idea of the range and variability of the climate of Western Graham Land.

In addition, the relatively close network of stations in the South Shetland Islands and West Graham Land allowed synoptic analysis of the weather in Drake Passage and the Falkland Islands Dependencies. Nevertheless, Dr. Maling introduced a note of caution in the interpretation of these observations. Not one of the Falkland Islands Dependencies Survey bases could be said to have good meteorological exposure. Surface winds, in particular, were considerably affected by local topography and this added to the difficulty of drawing reliable synoptic charts. In view of these difficulties, it is a matter for regret that radiosonde ascents were not made from any of these bases until 1955.

Dr. Maling then turned to other routine observations carried out at each base. He noted that there was now a considerable amount of information about the seasonal movements of sea-ice and the dates of winter freezing of the sea. The analysis of this would have great practical value and would reinforce the summer observations made by the whaling fleets in the open ocean. He regretted the almost complete absence of any routine glaciological work and emphasized that useful observations could be made at every base with relatively limited equipment. With the exception of 1949, when observations of glacier regime were made in both the South Shetland and South Orkney Islands, there were scarcely any quantitative figures for accumulation and ablation.

Dr. Maling then considered the state of topographical surveying in the Falkland Islands Dependencies. The outlines of the main island groups and the coast of western Graham Land were surveyed before the War and, indeed, much of the remaining country had been seen from the air before 1940. Nevertheless, the earlier surveys were largely coastal surveys, and Falkland Islands Dependencies Survey surveyors have made detailed topographical maps of the peninsula and the interior of many of the larger islands. In particular, three important sledge journeys, made during 1946 and 1947, carried accurate ground survey from Hope Bay to the western edge of the Filchner Ice Shelf throughout the length of eastern Graham Land, which was hitherto unmapped. There are, however, many places where the existing surveys are inadequate and the methods by which these areas might be mapped depend upon the accessibility of the Graham Land plateau from the coast. Although aerial photography might appear to provide

the quickest method of completing the work, the unreliable weather of the Antarctic inevitably causes difficulty and delay. The lack of success of Hunting Aerosurveys, Ltd., during their first season's operation from the South Shetlands, was largely owing to the bad flying weather during January and February 1956.

Dr. Maling concluded by stating that the work of the Falkland Islands Dependencies Survey is concentrated upon routine observations and careful systematic investigation of the more accessible parts of the Dependencies rather than seeking to make dramatic discoveries in the continental interior. To a certain extent, this policy has been dictated by the political expediency of maintaining continuous residence; but, from a scientific point of view, such a policy is most desirable, for the continuity of routine observations cannot be achieved in any other way. In this sense, much of the work of the Survey has the same monotonous unspectacular quality as the patient marine research of Discovery Investigations between the Wars.

Dr. Maling was followed by Mr. H. H. Lamb, of the Meteorological Office, who spoke on "Winds and Weather" in the Antarctic. Mr. Lamb's work on the synoptic meteorology of the whole continent is inevitably conjectural owing to the paucity of observations in east Antarctica. Nevertheless he has been able to compile synoptic charts for the summer months when whaling fleets are active, and these charts show much greater variability in the pressure systems than has hitherto been acknowledged. Indeed, the glacial anticyclone of Hobbs is largely mythical and although high-pressure systems occur over east Antarctica for perhaps 85 per cent of the year, these tend to break down and frontal activity affects all parts of the continental interior. Mr. Lamb noted that the high-pressure systems seldom develop sufficiently to move northwards and block the general westerly circulation along the polar front, but it is possible that since his examples were largely based upon summer observations, this feature may be more common in winter. He further noted the asymmetrical arrangement of pressure around the continent and observed that there may be a semi-persistent trough line which lies between the Weddell Sea and Ross Sea. He ventured to predict that if the trans-continental party were forced to travel westward of their direct route, they might be confronted with persistent head winds.

Mr. Lamb then discussed possible reasons for abnormal wind speeds in certain parts of Antarctica. He showed some maps which expressed the frequency of gales in different parts of the continent and showed that the persistent Adelie Land gales could only be caused by some topographical effect. He attributed this to 'frontal funnelling' or the concentration of air-flow between a mountain barrier and frontal surface. Observations in Greenland and comparison with the local winds of the Mediterranean suggest that abnormally high winds may be caused for a considerable distance downwind of the mountains, and he concluded that the gales experienced in Adelie Land may well result from an unrecorded mountain range in the continental interior.

The paper by Dr. W. Campbell Smith (British Museum (Natural History)), entitled "Some Geological Results of the Expeditions to South Victoria Land up to 1914", was taken as read, owing to lack of time.

D. H. MALING

ANTI-OXIDATION

THE importance of antioxidant chemistry to technology was emphasized by the fact that during the British Association meeting in Sheffield, on August 31 a full morning session of Section B (Chemistry) was devoted to papers on this subject. Quite apart from its fundamental value in understanding oxidation processes, the advances in the field of the chemistry of antioxidants have played an important part in the development of high-performance petrols and lubricating oils, in the prevention of oxidative deterioration of rubbers and plastics, in the preservation of foodstuffs and in other processes in which air oxidation gives rise to undesirable effects.

The session was opened with an introductory paper by Prof. C. E. H. Bawn, who reviewed the fundamental concepts and the chemistry of the types of molecules which readily undergo antioxidation in the liquid state in air or in solution at ordinary temperature. Recent research, he said, has been particularly successful in providing a clear picture of the course of the oxidation reaction, and certain generalizations have emerged from this work. The more important of these are that the oxidation occurs by a chain reaction which may be initiated either by oxygen or a catalyst and that the reaction of oxygen occurs without the breaking of the O—O bond to form a hydroperoxide. The reaction chain has been established to be of the following type:

Initiation	$RH \rightarrow$ free radical R
Propagation	$R + O_2 \rightarrow RO_2$ $RO_2 + RH \rightarrow ROOH + R$
Termination	$R + R \rightarrow$ $R + RO_2 \rightarrow$ $RO_2 + RO_2 \rightarrow$ } inactive products

in which RH = hydrocarbon, aldehyde, etc.

The decomposition reactions of the initially formed hydroperoxide are the source of many diverse substances such as aldehydes, esters, acids, alcohols, etc., some of which are responsible for the development of undesirable properties. For example, rancidity of fats is usually attributed to the formation of aldehydes; the modification and deterioration of rubbers and plastics, which is manifest by a change in mechanical properties, is a result of oxidative scission of the high-polymer molecules by radicals formed in the hydroperoxide decomposition reaction.

Salts of heavy metals, which are widely known to promote oxidation, are usually present in minute amounts in processed or refined materials and act by decomposing the hydroperoxide into free radicals; for example:

$$ROOH + Me^{2+} \rightarrow RO_2 + H^+ + Me^+$$
$$ROOH + Me^+ \rightarrow RO + OH^- + Me^{2+}$$

The function of the antioxidant is to inhibit or retard the oxidation reaction, and this is attained

either by interruption of the reaction chain leading to hydroperoxide formation or by influencing the hydroperoxide decomposition reactions in such a way as to form products which no longer act as chain initiators. The most commonly used antioxidants are substances which react with the transient RO_2 radicals. These compounds usually, although not invariably, possess a readily removable hydrogen atom, and one of the principal reactions by which antioxidant effects are achieved is:

$$RO_2 + AH \rightarrow ROOH + A$$

The radical A formed from the antioxidant AH is unable to continue the chain reaction and disappears either by reaction with itself or another RO_2 radical. Much evidence supports this mechanism for a number of phenols and amines, which are the two main types of compounds used as inhibitors. The structure of the phenol or amine has a considerable influence on its effectiveness as an inhibitor, and many features of the reaction are still not fully understood. The pro-oxidant effects of trace metals mentioned above may be overcome by addition of substances which chelate with the metal ion and render it inactive.

The problems associated with particular aspects of the use of antioxidants in industry were presented in three papers dealing respectively with the food industry (Dr. C. H. Lea), the oil industry (Mr. C. N. Thompson) and the rubber industry (Mr. J. T. Watts).

Dr. Lea said that many constituents of food such as unsaturated fats, fat or water-soluble vitamins, colouring and flavouring matters react with atmospheric oxygen during the period between preparation and consumption. In the plant or animal these processes are kept under control by a complicated enzymatic process, but in the dead tissues or in food processed from them degradative reactions occur. These reactions, which are believed to occur via a peroxidic mechanism similar to that mentioned above, lead to the spoilage of foods. Although this tendency is opposed by natural anti-oxidants associated with the foodstuff, many of these materials are removed during processing and refining. The natural antioxidants—of which phenols constitute the largest number—are of particular importance to the food industry, and many have been isolated and identified. Of these, tocopherols (vitamin E) are best known and occur widely in vegetable and animal fat-containing tissues. Other naturally occurring phenolic antioxidants include dihydrocaffeic acid, flavones, tannins and catechol derivatives. Many acidic substances such as citric or phosphoric acids, which themselves possess no antioxidant activity, influence very considerably the activity of phenolic inhibitors either already present or added to food. Such 'synergists' include cephalin, ascorbic acid and other organic acids.

It was pointed out by Dr. Lea that the requirements for a successful antioxidant for use in food are very strict, in that in addition to producing a useful degree of stabilization it must be non-toxic before and after oxidation, be adequately dispersable and must impart no colour, odour or flavour. The conditions are attained after prolonged and extensive testing and even then a very wide margin of safety is specified. Only in recent years has the use of chemical antioxidants been approved in Britain, although their use is extensive in certain countries abroad and particularly in the United States.

In discussing the use of antioxidants in the oil industry, Mr. Thompson said that during the past twenty or thirty years, advances in the field of anti-oxidants have played a vital part in the great strides made in the development of high-performance oil products. As judged by the papers published on the subject, the amount of research work on antioxidants has continued to increase steadily over this period, and the pace was virtually uninterrupted during the Second World War.

About ten million pounds' worth of antioxidants is used every year in petroleum fuels and lubricants to ensure that they have adequate oxidation stability for the jobs that they have to do. This amounts to nearly 50,000 tons per annum, more than 90 per cent of which is used in lubricants. There are many kinds of antioxidant. The type selected for use in a particular product depends on the nature of the oil product itself, and on the conditions of oxidation likely to be met in service; for example, operating temperatures and amount of contact with air and engine or equipment parts made of copper and iron, which are powerful catalysts of oxidation. Tiny amounts of antioxidants can effectively reduce or completely stop oxidation for long periods, fifty-fold improvements in stability being common.

Two or more kinds of antioxidant may be used together in an oil product to combat the various oxidation influences. The amounts needed vary greatly with the severity of service requirements. The petroleum industry manufactures an enormous number of oil products, and great care has to be taken to ensure that the best oil product/antioxidant combination is available for each of a wide variety of purposes. This is achieved by making use of the knowledge that has been gained in recent years of antioxidant behaviour. For example, different oil products do not respond equally well when the same antioxidant is added to them, and some can be improved in their oxidation-resistance much more than others. Moreover, the effectiveness of some antioxidants varies enormously according to the conditions under which oxidation is occurring. An antioxidant which is superior to others under one set of conditions may not be the best in different circumstances.

Studies involving the assessment of antioxidant activity during the service life of an oil product are valuable in indicating oil-change periods or the need for better products to withstand the more severe conditions to be expected in the future. Extensive field-trials are imperative to supplement laboratory experiments. As to the future trends, the jet engine will impose new demands on the oxidation stability of both lubricants and fuels. It is expected, for example, that in supersonic aircraft capable of 1,500–2,000 m.p.h., the fuel may have to be used to provide not only the power but also the cooling that will be necessary to overcome the thermal barrier.

In introducing the subject of the use of anti-oxidants in the rubber industry, Mr. Watts referred to the wide range of materials both synthetic and natural which are now available to the industry, and to the basic methods of processing and vulcanization. The important antioxidants now in general use belong to two groups of chemicals, namely, (*a*) amines and their derivatives, and (*b*) phenols and their derivatives, the essential difference in performance of the two types being in the degree of staining imparted to the vulcanizate. He summarized the properties of the amine derivatives as regards their behaviour towards natural ageing, heat ageing, flexing, staining and metal impurities in terms of the broad classi-

fication of ketone–amine condensates, aldehyde–amine condensates and secondary aromatic amines. Phenols and their derivatives are mainly of interest on account of the low degree of staining which they impart to the vulcanized rubber. Copper salts, in small amounts, are usually introduced into rubber via the raw materials or in processing, and since these salts are powerful oxidation promoters, it is essential to use copper inhibitors to ensure satisfactory service use of the rubber. Heat and light increase the rate of oxidation, the effect of heat being an increase in stiffness and a decrease in elongation, while light causes crazing due to the production of an inelastic skin. It is essential to add suitable antioxidants to delay these effects. Also the use of anti-flex cracking antioxidants is one of the most important branches of rubber chemicals, their importance arising from the demands of the tyre industry. Amines and their derivatives such as phenyl-β-naphthylamine, diphenyl-*p*-phenylene diamine and dimethoxy phenylene diamines are effective antioxidants for the purpose.

Ozone in minute quantities is one of the most powerful agents for producing cracks in strained rubber, and the concentration normally present in the atmosphere is sufficient to produce cracking. Various methods have been proposed for overcoming this problem, such as the use of wax or varnish film on the rubber. Phenylene diamines in concentrations of 2–4 parts for 100 parts rubber hydrocarbon have been claimed by the Americans to give good protection against ozone. These are used together with other antioxidants. C. E. H. Bawn

NEWS and VIEWS

Psychology at Reading: Prof. M. D. Vernon

Dr. M. D. Vernon, who has been appointed to succeed Prof. R. Oldfield (*Nature* of June 16, p. 1109) in the chair of psychology in the University of Reading, has not only gained an international reputation among students of visual perception as an experimenter, but also has had long and wide experience of psychological work in the field, particularly in industrial and social connexions, and in the study of children. A scholar of Newnham, she was placed in Class I of the Natural Science Tripos and started research in the Cambridge Psychological Laboratory under Mr. (later Sir Frederic) Bartlett in 1922. She remained at Cambridge until 1946, as a member of staff, at first of the Industrial Health Research Board and later of the Medical Research Council. Her earlier work was chiefly in the field of industrial psychology, in which her father, the late Dr. H. M. Vernon, is remembered as an outstanding pioneer. From 1927 onwards she was engaged in a series of studies of visual perception, of uncommonly solid and coherent character. Apart from the scientific value of her findings, these set a standard of patience and rigour which her students and colleagues could not fail to appreciate. During the same period she produced two major works, "Visual Perception" (1937) and "Further Studies of Visual Perception" (1952), the sound scholarship of which have guided and helped those of like interest everywhere. She joined the Department of Psychology at Reading as lecturer in 1946, and became reader in 1956. Dr. Vernon has performed numerous and varied services to her colleagues and her subject, notably as assistant to the editor of the *British Journal of Psychology* during 1932–48, as president of the Experimental Psychology Group during 1952–54, and as president of the Social Psychology Section of the British Psychological Society during 1948–49. Her active interests, backed by full experience in teaching, research and administration, promise a fruitful development of the Reading Department along the catholic yet distinctive lines impressed upon it by the first holder of the chair, Prof. A. W. P. Wolters.

Organic Chemistry in Sydney: Prof. C. W. Shoppee, F.R.S.

The appointment is announced of Prof. C. W. Shoppee to the chair of organic chemistry in the University of Sydney, in succession to Prof. A. J. Birch. Prof. Shoppee's earliest researches were carried out in 1923 at the Imperial College of Science and Technology, London, under Dr. C. K. Ingold, with the nominal direction of the late Sir Jocelyn Thorpe. In 1924, he accompanied Prof. Ingold to the University of Leeds, and in 1928, after having held an 1851 Senior Studentship, was appointed to the staff of that University. In 1939, he was elected to a Rockefeller Research Fellowship, which he chose to hold in the Laboratory of Prof. T. Reichstein at the University of Basle. In 1944 he was appointed to a readership in chemistry in the University of London, tenable at the Royal Cancer Hospital, and, in 1948, to the chair of chemistry in the University of Wales, at University College, Swansea.

Prof. Shoppee is distinguished for his contributions to organic chemistry, and especially for his work in collaboration with Prof. Reichstein on the hormones of the adrenal cortex, which led to the establishment of the detailed structures of these physiologically important compounds. At the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital), he applied his special knowledge of the microchemical and chromatographic investigation of natural products to problems of the isolation and identification of endogenous carcinogenic substances present in human tissues. In the steroid field, Prof. Shoppee rapidly gained an international reputation, and his later work involved application of the newer conceptions of the mechanism of organic reactions to the determination of chemical configuration in natural products, an ultimate aim being to illuminate the highly specific relationship between molecular configuration and physiological activity. These aims he has continued to pursue at University College, Swansea, where he has been successful in building a vigorous school. In collaboration with Dr. K. W. Sykes (now professor of physical chemistry at Queen Mary College, London), he was able to promote work on high-temperature kinetics, and more recently has introduced fundamental and applied infra-red spectroscopic studies in association with Dr. H. E. Hallam, and, finally, the complementary study of Raman spectra, in association with Dr. D. A. Long. Prof. Shoppee was elected to the fellowship of the Royal Society in March of this year.

E. B. Wilson (1856–1939)

One of the most distinguished of pioneer experimental embryologists, Edmund Beecher Wilson was born in Geneva, Illinois, a hundred years ago on October 19, 1856. He was educated at Antioch College, Ohio, at the Sheffield Scientific School, Yale, and at Johns Hopkins University, where he obtained the Ph.D. in 1881. In 1885 he became professor of biology at Bryn Mawr College, Pennsylvania. After spending a year in Europe, where he worked with Theodor Boveri at Munich and with Hans Driesch and C. Herbst at the Naples Zoological Station, Wilson was invited by Henry Fairfield Osborn in 1891 to take the post of adjunct professor in the newly established Department of Zoology at Columbia University, New York; he was appointed Da Costa professor of zoology there in 1914. In his first important work, "The Development of Renilla" (*Phil. Trans. Roy. Soc.*, 1883), he made skilled use of serial sections, which were just coming into practice. "The Cell Lineage of *Nereis*" (1892) aroused the interest of American workers in this field of research. In 1901 Wilson showed that accessory asters (T. H. Morgan's "cytasters") form in fertilized *Sphaerechinus* eggs under the influence of hypertonic sea water. From 1903 onwards he concentrated his attention on the chromosomes, particularly on their behaviour during the maturation of the germ-cells, and one of his graduate students, W. S. Sutton, pointed out that the manœuvres of the chromosomes furnish the mechanism for Mendel's two laws of heredity. Wilson's book, "The Cell in Development and Heredity" (1896, third ed. 1925), rapidly became a classic. Of the numerous honours that he received it may be mentioned that he was a foreign member and Croonian Lecturer of the Royal Society, gold medallist of the Linnean Society, and president of the New York Academy of Sciences, the American Academy of Arts and Sciences, and the Society for Experimental Biology and Medicine. A scientist who combined to a remarkable degree artistic workmanship with balanced judgment, and a quiet, cultured gentleman, Wilson died on March 3, 1939, at the age of eighty-three.

L. G. Groves Memorial Prizes and Award

The L. G. Groves Memorial Prizes and Award, given annually from a grant of money placed at the disposal of the Air Ministry in 1946 by Major Keith Groves, J.P., and Mrs. Groves, of Maughold, Isle of Man, in memory of their son, Sergeant Louis Grimble Groves, a meteorological observer who lost his life on a weather flight in 1945, have been awarded this year as follows: *L. G. Groves Prize for Aircraft Safety:* Wing Commander F. Latham, of the R.A.F. Institute of Aviation Medicine, for research into the physiological factors involved in the abandonment of aircraft and in particular the effects of explosive ejection upon the human body; *L. G. Groves Prize for Meteorology:* F. H. Bushby, senior scientific officer, Meteorological Office, Dunstable, where as a member of the forecasting research team of the Napier Shaw Laboratory, Dunstable, he has worked with marked success on dynamical problems and especially on the applications of the equations of fluid dynamics to forecasting, using electronic computing machines; *L. G. Groves Award for Air Meteorological Observers:* Flight Sergeant J. D. Moyes, for meritorious work while serving as an air signaller on meteorological duties with No. 202 Squadron, having completed some 220 meteorological flights totalling nearly 2,000 flying hours.

Proposed Expansion of the La Jolla Campus of the University of California

At a meeting of the Regents of the University of California, held in Berkeley last August, it was decided to expand the University's campus at La Jolla, near San Diego in southern California, including also the Scripps Institution of Oceanography at La Jolla which has been a part of the University since 1912. The Regents agreed that the expansion should take place gradually over a period of years and that it should be based on the growth of the existing facilities at La Jolla for undergraduate instruction and advanced work in mathematics, physics, chemistry and the earth and biological sciences. In this way it is hoped that the rapidly increasing human and material resources of the southernmost part of California will be more fully marshalled for the betterment not only of the University but also of the State of California and the United States generally. In welcoming the new plan, the director of the Scripps Institution, Dr. Roger Revelle, said that the expansion of the University's activities in the San Diego region can be expected to bring great material and cultural benefits to every part of the community; the development will necessarily have to be carried out carefully and slowly, and generous private endowments and ample public funds will be necessary.

Siemens–Ediswan Research Laboratories

Plans have recently been made for new Siemens-Ediswan Research Laboratories which will serve the research activities of Siemens Brothers and Co., Ltd., and of Edison Swan Electric Co., Ltd., the scope of the work being the whole field of telecommunications and various aspects of cable research. It has been decided to erect a group of buildings on a 3½-acre site at Harlow, at the junction of Edinburgh Way and No. 1 Avenue. The first stage of the building plan, which it is hoped to complete in two years, includes three single-story laboratories and one three-story block containing entrance hall, conference room, lecture room and library, as well as laboratories and offices. This will provide accommodation for a total staff of 100–150. Later stages are envisaged in which the three-story building will be increased to five stories, the single-story buildings will be increased to two, and at least three additional structures will be erected. It is not proposed to concentrate the whole of the research staff at Harlow. Sections of the Laboratories will continue to operate near the main factories at Woolwich, Sunderland and Lydbrook. Dr. G. W. Sutton, director of research and education, Siemens Brothers, Woolwich, has been appointed director of the new laboratories.

Land Utilization of Cyprus

Geographical Publications, Ltd., have published a Land Utilization Map of Cyprus in the World Land Use Survey, directed by Dr. L. D. Stamp. The map constitutes an excellent record of the use made of the Island's land about 1949 and, unless great changes are made quickly, it is likely to stand for several years more. The generalizations necessitated by the use of a short key and by the scale of the map (4 miles to 1 inch) tend to simplify the picture unduly, and it says much for the ingenuity displayed in the preparation of the map, for it is not an easy matter to determine the land use and plot the data from a study

of about 10,000 air photographs. Those who know Cyprus will be aware of the meaning to be attached to such mixed categories as "tree and other perennial crops with unimproved grazing land"; but those who do not are liable to draw incorrect conclusions unless they have been forewarned. The Island's land is about equally divided between crop land and unimproved grazing land and forest together, which says much for the persistence and patience of the Cypriots who cultivate the land, often with simple implements, and also for the work of the Forestry Department which has been enabled, by legislation and other methods, to do so much for the re-establishment of the forests. Changing age-old methods of cultivation and overcoming fragmentation of holdings makes the Agricultural Department's task more difficult. The map is well produced, and clearly printed so that detail can be seen without difficulty.

Distribution of Mistletoe

A SHORT account of the way mistletoe is distributed is given by D. J. Cove in *The Starfish*, the journal of the Association of School Natural History Societies (No. 9; July 1956). The inquiries started in the Bishop's Stortford district and have now developed into a national survey. Tentative conclusions show that mistletoe is mainly found in old trees and indicate that man, rather than birds, is the chief agent in distribution. On the larger trees, mistletoe tends to grow near the apex of the crown, or towards the sides, where it is beyond the easy reach of man. One possible explanation for this, which does not involve man, is that the light is too weak in the centre of the tree for photosynthesis in mistletoe to take place. Another explanation is that the birds distributing the seeds tend to frequent the outer parts of the tree's canopy. It is evident from the records submitted that, although *Viscum* grows on a wide range of hosts, distribution through this range is very uneven. Of the thirteen families involved, the Rosaceae alone account for nearly 70 per cent of the infested plants; and apple trees are the commonest hosts by far (42 per cent). Records of host-plants which are particularly worth noting include *Parrotia*, silver fir and, in view of its association with mistletoe at the festive season, holly. In spite of all that one reads about the attention paid by Druids to mistletoe growing on oak, only a single case of an infested oak has been reported. The present survey has produced some circumstantial evidence in support of the existence of 'strains' differing in the range of hosts they infest. More records will be needed before firm conclusions can be made about the validity or otherwise of these 'strains'.

New Zealand Forest Service: Report for 1954–55

THE annual report of the Forest Department of New Zealand, covering the period April 1954–March 1955 (pp. 103. Wellington: N.Z. Forest Service, 1955), commences by commenting on the remaining indigenous forests of the country which, after being completely ignored during the great exotic coniferous campaign of the earlier years of this century, have been receiving attention for some years. They are sylviculturally necessary as an insurance against widespread devastation of the exotic forests by disease or fire, in addition to being a source of invaluable specialist timber. A long-term objective for this indigenous forest is to bring as much as possible as soon as possible into a state of greatest productivity. Until recently, it was considered that conservation was best served by complete control of the indigenous cut. This has proved impracticable. The approach is now to be sylvicultural, and this is of considerable interest. The area is to be regenerated, artificially or naturally, with the main native forest timber species—the kauri, the podocarps and the beeches. Practice in Queensland, Australia, and research in New Zealand offer evidence that kauri can be artificially established as a productive crop. The good conifers have been subject to intensive study, and new management methods begun. The beech forest, so long neglected, shows great promise under management, and beech timbers are now widely used and respected. An interesting introduction is a Forest Biology Survey for the purpose of detecting population build-ups of any forest organism; thus outbreaks of insects or disease may be dealt with in their early stages.

Zoological Nomenclature

THE International Commission on Zoological Nomenclature will start to vote, as from February 24, 1957, on the following cases involving the possible use of its plenary powers, full details of which have already been published (*Bull. Zool. Nom.*, **12**, Pts. 6–8; August 24, 1956): (1) *alligator* Blumenbach, 1779 (*Lacerta*), suppression, to protect *mississipiensis* Daudin [1801–1802], (*Crocodilus*) (cl. Reptilia); (2) *Campsicnemus* Haliday, 1851, validation (cl. Insecta, order Diptera); (3) *Elaphella* Bezzi, 1913, and *Lophiotherium* Gervais, 1850, validation (cl. Mammalia); (4) *verrucosa* Sars, 1901 (*Alona*), validation (cl. Crustacea, order Cladocera); (5) *Candona* Baird, [1846], designation of type species for and *Herpetocypris* (emend. of *Erpetocypris*) Brady and Norman, 1899, validation (cl. Crustacea, order Ostracoda); (6) *Conchoecia* (emend. of *Conchaecia*) Dana, 1849, validation of and designation of type species for (cl. Crustacea, order Ostracoda); (7) *Anchisauripus* Lull, 1904, and *Otouphepus* and *magnificus* (*Otouphepus*), both of Cushman, 1904, suppression (cl. Reptilia Theropoda [Ichnites]). Comments should be sent as soon as possible to the secretary to the Commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Folk-Lore

THE note in *Nature* of September 8, p. 522, on *Gwerin*, the new journal of folk-lore, ends with the sentence: "There is, indeed, room for a journal devoted to folk-lore, and all will wish the new venture every success". It has been pointed out to the Editors that this might give the impression that *Gwerin* is the only periodical devoted to folk-lore. This, of course, is not the case, for the periodical *Folk-Lore*, the quarterly journal of the Folk-Lore Society (c/o University College, Gower Street, London, W.C.1), has been in existence since 1878 and is still an excellent publication (often referred to in *Nature*) which deals with every aspect of folk-belief, tradition, custom and folk-lore research both in Great Britain and elsewhere.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: H. Bailey (agricultural officer, Gambia), agricultural officer, Northern Region, Nigeria; J. D. A. Harris (agricultural officer, Sierra Leone), senior agricultural officer, Western Region, Nigeria; H. P. Burgess (conservator of forests, Western Region, Nigeria),

chief conservator of forests, Western Region, Nigeria; J. A. G. Ellis (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; M. T. Horwood (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; T. W. Hussey (senior assistant conservator of forests, Federation of Nigeria), conservator of forests, Federation of Nigeria; A. L. Roxburgh (assistant conservator of forests, Eastern Region, Nigeria), senior assistant conservator of forests, Eastern Region, Nigeria; G. J. Wiley (laboratory technologist, Department of Veterinary Services, Kenya), zoologist (entomology), Department of Veterinary Services, Kenya; F. Wilson (field officer, East Africa Trypanosomiasis Research Organization, East Africa High Commission), field officer, Veterinary Department, Uganda; Miss J. A. K. Abel (assistant statistician, Gold Coast), statistician, Gold Coast; E. C. Innerarity (statistician, Jamaica), senior statistician, Jamaica; P. S. L. Benton, specialist assistant, Agricultural Department, Northern Region, Nigeria; R. Briggs, agricultural officer, Somaliland; G. B. Cliff, C. A. Jackson and J. M. Suttie, agricultural officers, Kenya; I. R. Jensen, irrigation engineer, Agricultural Department, Northern Region, Nigeria; A. M. MacDonald, P. J. Myers and M. A. Owen, agricultural officers, Tanganyika; E. C. Patterson, agricultural officer, Aden; H. Rostron, agricultural officer, Nyasaland; C. B. Sykes, agricultural officer, Northern Region, Nigeria; M. J. van den Heuvel, pest infestation control officer, Produce Inspection Service, Northern Region, Nigeria; P. C. Kimber, assistant conservator of forests, Tanganyika; P. J. Sheldrake, assistant conservator of forests, Sierra Leone; R. H. Watson, assistant conservator of forests, Uganda; R. K. Evans, geologist, Nyasaland; E. Robinson, geologist, Jamaica; A. C. Hayward, process microbiologist, Colonial Microbiological Research Institute, Trinidad; E. C. Hislop, scientific officer (plant pathologist), Tanganyika; J. B. Roberts, scientific officer (organic chemist), Colonial Microbiological Research Institute, Trinidad; W. Bruce, veterinary research officer, Kenya; G. D. Paine, veterinary officer, British Guiana; P. H. S. White, veterinary officer, Northern Rhodesia.

Announcements

The Herbert Spencer Lecture for 1956 of the University of Oxford will be delivered by Sir Edward Bullard on December 4, at noon, his subject being "The Interior of the Earth".

Miss Mary George, principal information officer, Ministry of Agriculture, Fisheries and Food, has been appointed director and secretary of the Electrical Association for Women in succession to Dame Caroline Haslett.

Dr. Edward Wenk, jun., has been appointed chairman of the Department of Engineering Mechanics of the Southwest Research Institute, Texas. He is an authority in the fields of stress analysis, naval architecture and building design and construction, and was formerly head of the Structures Division of the David Taylor Model Basin, Washington, D.C.

Prof. G. P. Wright, Sir William Dunn professor of pathology in the University of London at Guy's Hospital Medical School, and Denis Hill, senior lecturer in clinical neurophysiology, Maudsley Hospital, London, and physician and lecturer in psychological medicine at King's College Hospital, London, have been appointed members of the Medical Research Council. The Earl of Limerick and Sir Geoffrey Vickers have been reappointed for a further term of office.

An international conference on rock magnetism, under the auspices of the International Council of Scientific Unions, will be held during November 1–3 in the Imperial College of Science and Technology, London, with Prof. P. M. S. Blackett as chairman. Those wishing to attend should write before October 18 to Dr. J. A. Clegg, Department of Physics, Imperial College, London, S.W.7.

The National Institute of Agricultural Botany is holding its Crop Conference for 1956 in Cambridge at the Union, Bridge Street, during December 12–13. The general theme will be "The Choice of Seed by Farmer and Grower", and sessions will be devoted to the seed testing service, vegetable crops, and wheats for the farmer to grow and sell. Further information can be obtained from the Secretary of the Institute at Huntingdon Road, Cambridge.

The French Society of Metallurgy is holding its annual "Journées Metallurgiques d'Automne" in the Maison de la Chimie, 28 rue Saint-Dominique, Paris 7e, during October 22–27. Further information can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

The Fullers' Earth Union, Ltd., a member of the Laporte Group of Companies, has offered a scholarship to the Chemistry Department at the Imperial College of Science and Technology, London, to support and develop research in progress within the Department on the chemistry of clays. The studentship, which is of the value of £350 a year plus fees, is held in the first instance by Mr. G. S. Perry, who will study the intercalation of organic mixtures by clay minerals and the efficiency of such minerals in chromatographic separations.

The B.B.C. is presenting one or two research scholarships each year of £385 per annum to university graduates in electrical engineering or physics, to enable them to work for a higher degree at any university in the United Kingdom. The scholarships are for two years in the first instance, and are limited to male British subjects. The subject for research must be in fields of telecommunications or physics having an application to sound or television broadcasting. The Corporation has awarded one research scholarship only this year, to Mr. P. C. J. Hill (University of Birmingham), who will work in the Department of Electrical Engineering, Imperial College of Science and Technology, under the supervision of Dr. D. Gabor.

Reference was made in *Nature* of September 29 to the separate publication of Appendix III of the 1956 issue of the "Yearbook of the Universities of the Commonwealth". This appendix gives the number of overseas students in British university institutions. The corresponding Appendix III for the 1957 issue of the "Yearbook" has now been issued. This shows that for the academic year 1955–56 the total number was 9,723 (8,467 men, 1,256 women), as compared with 9,050 in 1954–55.

Erratum. In the review entitled "Techniques and Theory of Molecular Beams" by Dr. E. H. S. Burhop (*Nature*, 178, 608; 1956), the name "Rutherford" should read "Retherford". We regret this error.

HIGH-TEMPERATURE RESEARCH

SYMPOSIUM AT THE UNIVERSITY OF CALIFORNIA, BERKELEY

A SYMPOSIUM on "High Temperature: a Tool for the Future" was held on the campus of the University of California, Berkeley, California, during June 25–27. This meeting was sponsored by the Stanford Research Institute and the University of California. Most of the 600 attending the symposium were from the United States; but other countries were also represented.

The subjects were dealt with in three major categories, one each day, namely: methods for reaching high temperatures, materials for containing high temperatures, and processes occurring at high temperatures. The chairmen for the three-day meeting, successively, were Dr. Nevin K. Hiester, of Stanford Research Institute, and Profs. Alan W. Searcy and Leo Brewer, of the University of California. To pinpoint the discussion further, each of the major divisions—methods, materials and processes—was divided into three areas for discussion by separate panels, a panel consisting of a leader and three others. Thus virtually every aspect of high-temperature research was discussed in thirty-six short papers and in the answers to questions from the floor, in addition to the luncheon address by Dr. Theodore von Kármán, chairman of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, whose subject was "Aerodynamic Heating—the Temperature Barrier in Aeronautics".

The opening discussion of several practical methods of obtaining high temperatures by producing images of a heat source covered both optical and mirror furnaces in many different arrangements, employing arcs, flames and the Sun as sources. One of the most novel furnaces was described by Dr. Joseph M. McGreevy, head of the Optics and Nucleonics Branch, Material Laboratory, New York Naval Shipyard. He described a radiant panel consisting of specially developed, long lamps with closely wound tungsten filaments supported in quartz by molybdenum disks. He reported heating a specimen with such a bank of lamps at a rate of 27 cal./sq.cm./sec. with a rather uniform spatial distribution of the heating-rate.

Dr. McGreevy also described another method of heating by direct radiation. In this, oxygen and aluminium rod are fed into the furnace, in which a pool of molten aluminium floats on a lake of aluminium oxide previously formed during the run. Because of the movement of the aluminium pool, this has been termed the skating-sun furnace. Combustion takes place in the cloud of aluminium vapour just above the pool of aluminium, which provides an irradiance of nearly 20 cal./sq.cm./sec. near the furnace with a temperature of about 3,200° K.

Dr. Wolfgang Finkelnburg, of the Siemens–Schuckertwerke Research Laboratory, described the use of high-intensity electric arcs by which temperatures up to about 53,000° K. have been obtained.

Dr. Finkelnburg outlined the particle composition of gases at temperatures from about 2,000° K. to millions of degrees. Of considerable interest was his description of a supersonic plasma jet produced by expanding a water-vapour arc, burning under 50 atmospheres pressure, through a DeLaval nozzle along the axis of the anode.

Of great interest was the discussion by Dr. Heinz Fischer, of the Cambridge (Mass.) Research Center, of electrical discharges of short duration by which temperatures of 250,000° K. have been achieved. He also mentioned the work reported in the U.S.S.R. of reactions, employing similar techniques, to touch a million degrees K.

As a background for the discussion of materials of interest at elevated temperatures, Dr. John C. Fisher, of the General Electric Co., presented a comprehensive analysis of the various mechanisms for failure in metallic materials exposed to heat. He presented the idea that high-temperature failure due to cavitation fracture may be controllable by suppression of the intergranular sites at which nucleation of the cavities occurs.

Several speakers pointed out that ceramic materials often show a reasonable amount of ductility at temperatures near their melting points. In particular, Prof. Earl R. Parker, of the University of California, cited several experimental phenomena that indicate the possibility of producing ductile ceramic metals. He showed motion pictures of experiments in which cakes of ice treated with surface-active agents were bent 15° before failure. A better knowledge of the influence of surface conditions on mechanical behaviour may lead to the development of ductile ceramic materials.

Progress in development of strong thin ceramic coatings was outlined by S. W. Bradstreet, of the Armour Research Foundation. Among the more interesting new techniques is that of flame spraying, which deposits a cohesive layer of oxide on a metal with little heating of the surface.

Some processes already under investigation require the use of materials near the melting points of the most refractory solids. Prof. J. T. Norton, of the Massachusetts Institute of Technology, directed attention to the fundamental chemical factors which result in materials of very high melting points. He demonstrated that high-melting materials can be divided into two distinct classes. The first class is characterized by saturated electronic pair-bonding. It includes such materials as silicon carbide and aluminium nitride. The other class consists of compounds of certain transition elements with such non-metals as carbon, silicon and boron. Prof. Norton believes the predominant factor in producing this second class of materials is a filling of the *d* shells of the metal atoms. He suggested that boron phosphide might prove a useful refractory of the first class and that ternary compounds, such as Ta–C–Si compounds, might yield new high-melting materials of the second class.

Because the efficiency of all types of nuclear reactors can be increased by raising the operating temperatures, the importance of the effects of high-energy radiation and fission-product accumulation on high-temperature structural materials is obvious. Because present reactor designs involve rather moderate temperatures, almost no work has been done so far

on the behaviour of materials at high temperatures in the presence of nuclear fission. There is some information on the effects of radiation on different types of materials at room temperature, however. This information was summarized by Dr. Clifford Weber, of the General Electric Company.

The effects of high pressures on the structure and properties of refractory materials were discussed by both Dean S. S. Kistler, of the University of Utah, and Dr. H. T. Hall, of Brigham Young University. Most startling of their comments was the fact that the melting point of certain refractories has been raised more than 1,000 deg. C. upon application of pressure. On the other hand, with substances that decrease in volume as they melt, the melting point is depressed by pressure. For example, germanium, under pressure, melts at a temperature 600 deg C. less than without pressure.

Although the details of the recently publicized successes in the manufacture of diamonds could not be disclosed, Dr. H. T. Hall, who was associated with that work, discussed some of its general aspects. In this he gave a striking example of the power of theoretical examination of high-temperature problems. He discussed a calculation demonstrating that known thermodynamic data for graphite and diamond and known kinetic data for conversion of diamond to graphite prove the impossibility of converting graphite to diamond in any temperature-pressure range achievable by conceivable means now possible for the investigation of phenomena that occur at pressures of 200,000 atmospheres and temperatures as high as 500° C.

Dean Kistler spoke of certain interesting resemblances of boron nitride to graphite. He directed attention to the fact that, from fundamental considerations, a cubic form of boron nitride with mechanical properties similar to diamond may be expected. The significance of such a possibility is obvious inasmuch as no known material has a hardness between that of boron carbide (2,700 Kroop K_{100}) and diamond (6,500). Dean Kistler held out the hope that a number of completely new materials may be formulated and produced, quite possibly with attractive high-temperature characteristics. As an example he remarked that a new form of silica has been produced simply by compressing quartz above 80,000 atmospheres. Cœsite was also mentioned by Hall as another modification of silica, produced by direct conversion from quartz heated to 2,000° C. at about 100,000 atmospheres pressure.

Dr. George Duvall and Dr. Milton C. Kells, of Stanford Research Institute, as well as Prof. B. H. Sage, of the California Institute of Technology, mentioned shock waves and high-speed nozzles as useful sources of high-temperature kinetic data. Reactions with half-times as low as five microseconds can be studied in shock tubes. A shock tube can yield a temperature of 11,000° K. in less than 12 μsec. High-temperature jets are being actively investigated as commercial sources of gases, such as acetylene.

Progress with the technique of melting and refining metals suspended in space by electromagnetic fields to avoid contamination with container walls was reported by I. E. Campbell, of the Battelle Memorial Institute, and J. C. R. Kelly, of the Westinghouse Electric Corporation. Kelly pointed out that the levitation-melting technique may also be useful for determining the surface tension of molten metals.

The Berkeley meeting made it clear that reactor and jet-engine development will continue to provide a tremendous impetus to research on high-temperature materials, and that high-temperature chemical processing is likely to witness spectacular expansion. It also demonstrated the comparative paucity of information in the high-temperature field. This was underlined by an example given by Kistler. He pointed out that, although silicon carbide is one of the oldest and best known synthetic high-temperature products, we still do not understand such things as the effects of furnace atmospheres on the rate of its formation, the factors determining whether the cubic or hexagonal form of the compound will be produced, or the effects of impurities on such important properties as conductivity, oxidation resistance, and grinding characteristics. Clearly, much remains to be done.

The papers given by the members of the various panels, with answers to the many questions put from the floor, are being printed and are expected to be issued about October 30; copies will be available from the Public Relations Department, Stanford Research Institute, Menlo Park, California (price 5 dollars each).

CHROMOSOME PROBLEMS

A CONFERENCE on chromosomes was held in the Landbouwhogeschool, Wageningen, Holland, during April 16–19, Profs. H. J. C. Tendeloo and R. Prakken being chairman and secretary respectively. The programme consisted of seven lectures with discussions.

Prof. E. Heitz (Tübingen) spoke first on chromosome structure in the nucleus, during mitosis and meiosis.

There are five different types of structural elements recognized in a chromosome: the spiral, the chromomeres, the centromere (primary constriction, kinetochore), the secondary constrictions (SAT-zones) and the heterochromatine. Four of these are directly (heterochromatin) or indirectly (the spiral, the centromere, the SAT-zones) demonstrable in the nucleus. These serve as proof of the individuality of the chromosomes within the nucleus.

The essential element of every chromosome, the spiral, which is tightly coiled during metaphase and anaphase, uncoils during telophase and gives rise, after the calymma has disappeared, to the thread-like structure of the nucleus. This structure has been observed in the living state and can also be demonstrated in the nucleus after fixation.

Often, certain parts of chromosomes do not uncoil during telophase and probably do not lose their calymmatic substance. Since such heterochromatic pieces occupy defined positions within the chromosomes, they can be recognized as more or less compact and highly coloured pieces in their respective positions.

Since rather large pieces of the chromosome on both sides of the centromere are often heterochromatic, the position of the centromere can be demonstrated in the proximal part of the young nucleus.

Chromomeres themselves (that is, compact, small and nucleal positive pieces within the anucleal uncoiled zygotene or pachytene chromosome-fibres seen during meiosis) cannot be demonstrated in the somatic nucleus, although heterochromatic pieces may be mistaken for them.

Secondary constrictions can be recognized in the nuclei by means of their function. They condense the nucleoli during telophase. Since the number and position of every secondary constriction are definite, the number and position of the nucleoli, in the young nuclei at least, correspond to the number and position of the secondary constrictions.

There are many indications that the major spiral contains a minor spiral. Furthermore, there are many reasons to suspect the existence of a third, perhaps molecular, spiral, running in the minor spiral, for example, the enormous length of the fibrils in the giant Dipteran chromosomes may thus be explained.

In addition, there are many indications that during anaphase there are already present two daughter spirals, at least. Electron-microscopic studies have shown that a sub-light-microscopical spiral is probably the basic element of every chromosome. If so, the known spiral should be composed of a bundle of different ultraspirals. Nevertheless, it is premature to seek a connexion between the proposed helical structure of deoxyribonucleic acid and the chromosome spiral.

Prof. H. D. Springall (University College of North Staffordshire) discussed the chemical structure of proteins and nucleic acids.

The study of an organic natural product follows the pattern: (1) isolation; (2) proof of purity; (3) estimation of molecular weight, and, if a macromolecule, molecular size and shape; (4) analysis; (5) degradation; (6) synthesis; (7) if a macromolecule, study of the configuration of structural elements within the molecule.

The application of this sequence of studies to proteins and nucleic acids is very difficult because of their very high molecular weights, and their fragility and intractability. The methods devised were briefly discussed and the results summarized.

(1) *Proteins.* These consist fundamentally of polypeptide chains of α-amino-acid residues (of about 19 different kinds). These chains are helical, most of them probably related to the 3·6 residue helix of Pauling. The helical chains are disposed in linear patterns in the fibrous proteins, and are folded into compact globular molecular shapes in the more soluble globular proteins.

The penetration of modern methods into protein structure is indicated by the analytical and degradative work which has established the complete structural framework of insulin (Sanger) and the complete synthesis of the nonapeptide amide hormones, oxytocin and vasopressin (du Vigneaud).

(2) *Nucleic Acids.* The building units of these are a few purine and pyrimidine N-bases; the sugars, ribose or deoxyribose (giving rise to ribo- or deoxyribo-nucleic acids); and phosphoric acid. There are many theoretically possible modes of assembly of these diverse and polyfunctional components. The natural scheme involves the linkage (*a*) (β-glycosidic) of an N-base to a sugar (to give a nucleoside), (*b*) (ester) of phosphoric acid to the sugar component of a nucleoside (to give a nucleotide) and (*c*) of nucleotides by phosphate diester formation via the 3′- and 5′-sugar positions. The polynucleotide chains in deoxyribonucleic acid are arranged in twin helices about a dyad axis (Watson–Crick). The arrangement in ribonucleic acid is not known.

Synthetic work on nucleic acids is of extreme difficulty and has not yet gone beyond dinucleotides (Todd).

(3) *Nucleoproteins.* The general structure of these substances, especially the viruses, was briefly considered.

Prof. T. Caspersson (Stockholm) spoke on the cytochemistry of the nuclear elements.

The lecture gave a summary of the early cytochemical studies of the metabolism of the cell nucleus, mainly carried through by aid of ultra-violet ultramicrospectroscopy. The central point had been the study of the role of the polynucleotides. Especial attention was given to the conspicuous changes in the protein content of various nuclear structures during mitosis and during the interphase, the functional stage of the cell.

In the latter part of the lecture it was pointed out that at a certain stage these studies were virtually entirely blocked by a series of technical difficulties, mainly arising when dealing with the protein components. This situation led to a comprehensive investigation aiming at development of the methods in different directions. Very recently major advances in this field have been reported and thus the cytochemical problems concerned in cell nuclear metabolism can now be attacked in a novel and hitherto inaccessible way. The technical procedures were not presented in any detail as very few data on chromosomes, gained with the new techniques, are, as yet, available. These are discussed, for example, in Cold Spring Harbor Symposia in Quantitative Biology, 1956.

Mr. N. W. Pirie (Rothamsted) dealt with the recognition, distribution, and action of nucleic acids.

There is no unequivocal way to recognize nucleic acid that has not been isolated. Methods depending on the determination of phosphorus extracted by different procedures can be confused by other phosphorus compounds; methods depending on the precipitation of the bases and determination of nitrogen are even more fallible; methods depending on the determination of ultra-violet absorption can be misleading both because of the presence of other substances with a similar absorption spectrum (for example, ascorbic acid) and also because of the effects of orientation. Feulgen staining for aldehydes is a more trustworthy method of recognizing deoxyribonucleic acid than any of the methods for ribonucleic acid; but here, too, there are difficulties.

The use of nuclease preparations increases the precision of these determinations; but their value depends on the demonstration, rather than the assumption, that the preparation is free from other relevant enzymes. Lack of action can be due to inaccessibility of the nucleic acid or to the presence of inhibitors. There is little evidence for the occurrence of free nucleic acid; but the nature of the linkage to proteins and other materials is obscure and probably diverse. This fact need not complicate histochemistry, because the techniques of fixation generally denature the protein and liberate any bound nucleic acid; but it complicates attempts to interpret the mode of action of nucleic acid, for the acid may be an artefact. There is some evidence for changes analogous to denaturation in nucleic acids; if such a phenomenon exists it extends still more widely the already ample possibilities for isomerism and specificity.

Deoxyribonucleic acid tends to be confined to the nucleus but is often found elsewhere, for example, egg-white and viruses, and may not have been looked for carefully. Ribonucleic acid is present nearly everywhere in organisms though it is often concentrated in regions such as microsomes and the

bacterial cell wall. Not all deoxyribonucleic acid is present as genes: What is the status of the common generalization that all genes are deoxyribonucleic acid? *A priori* this seems unlikely. Similarly, regions of high metabolic activity are often rich in ribonucleic acid: Are regions of protein synthesis characteristically richer still? It is surprising that there seems to be so little deoxyribonucleic acid–ribonucleic acid interconversion, and that actions such as the stimulation of polysaccharide and enzyme synthesis have been found so seldom.

Prof. A. Gustafsson (Stockholm) spoke on regularities and intentional control of mutation processes in plants.

From comparative experiments on barley, using X-rays, neutrons and specific chemical compounds as mutation-inducing agents, Gustafsson and his collaborators conclude that chromosome breakage and consequent X_1 sterility can be induced in barley by certain specific compounds: (1) without visible mutations of the chlorophyll apparatus, for example, 8-ethoxycaffein, (2) probably with such mutations, for example, ethylene oxide and mustards. Some agents, for example, nebularine, do not cause chromosome breakage, rearrangements, or X_1 sterility, but may increase mutation-rates considerably and cause fundamental changes in the mutation spectrum.

Chromosome breaks induced by strongly ionizing neutrons do not differ from those induced by X-rays. Random breaks, re-attached to form translocations, rarely produce noticeable changes in morphology, anatomy or ecology, but such translocations are highly instrumental in the genetical isolation of plant populations.

Plant-breeding in its genetical aspects rests on a profound knowledge of genes and chromosomes, the importance of heterochromatin and euchromatin, chromosome number, heterozygosity, gene recombination and mutation control. Mutations, whether spontaneous or induced, are generally regarded as arising at random. Gustafsson feels that this is not so. The mutation spectrum varies with the type of species and mutagenic agent used. The time does not seem far off when we shall be able to induce chromosome rearrangements and gene changes independently from one another, and control or direct the mutation process so that mutations of distinct loci, including those of high-productivity effects, are intentionally produced.

Prof. A. Müntzing (Lund) discussed chromosomes in relation to species differentiation and plant breeding.

Some species, although morphologically indistinguishable from one another, are isolated reproductively. Lewis's work on *Clarkia* has shown how a study of the differentiation of populations within a species can lead to an understanding of the mechanism of speciation in that group, and the part played by chromosome re-arrangements at the intra- and inter-specific levels. The salivary gland chromosomes of *Drosophila* have provided a means by which the nature of this chromosome differentiation can be studied in detail. In only a few cases has it been adequately demonstrated that the difference between two species is genic only and that chromosomal rearrangements have not occurred. Change in chromosome number to give an aneuploid series may result from fusion or breakage of chromosomes with diffuse centromeres.

Prof. Müntzing also spoke of the part played by polyploids in plant breeding and the value such plants had. Cytological analysis had shown the origin of many polyploid cultivated species and how they could be resynthesized, so that fresh genetic material could be incorporated into existing varieties. New polyploids have also been made and found to be of value in plants such as rye, clover, turnips and fruit trees. By the use of wheat plants lacking a pair of homologous chromosomes (nulliscomics) it has been possible to determine on which chromosome various genetic factors are situated and also to transfer whole chromosomes, bearing genes for disease resistance, to other varieties.

Prof. C. D. Darlington (Oxford) discussed the means of communication in the cell. These are to be inferred from chemical, genetical and radiation experiments and from comparative developmental studies. The co-operation and competition of nuclei had been revealed by classical experiments the meaning of which was now becoming clear in genetic and chemical terms.

The co-operation of gene activities and the co-ordination of chromosome movements both required communication along the chromosomes themselves. Evidence in relation to nucleoli, heterochromatin, and especially centromeres, showed that this communication was sometimes canalized along the chromosomes, a property which was variable and physiologically controlled. The inference of position effects from breeding experiments could thus be greatly extended. Further gene activity and integration could be seen as conditional not only on the local character of the cytoplasm but also on its cyclical changes. These cyclical changes in turn were co-ordinated in two normal systems (mitosis and meiosis) in every species. The relations of these normal systems were made clear by the abnormal systems which have now been described in many species and could be provisionally interpreted in terms of deoxyribonucleic acid and protein relations. With these cytological inferences the main concepts of genetics and embryology were consistent but they appeared in a new and larger perspective.

The author is indebted to Prof. C. D. Darlington (Oxford) and to Mr. K. M. Goodway (University College of North Staffordshire) for assistance in the preparation of this account. H. D. Springall

BRITISH WELDING RESEARCH ASSOCIATION

OPEN DAY AT THE ABINGTON LABORATORY

In our present society, which is committed to the pursuit of technology in support of a material standard of life, research associations and similar bodies form an essential communication between fundamental science and industry. This theme was developed by the Minister of Supply, Mr. R. Maudling, when proposing the toast of the British Welding Research Association at the annual luncheon and open day held at the Association's laboratory at Abington, Cambridge, on July 24. The Minister went on to encourage the production of memoranda containing the essence of sound practice supported by scientific investigation, the commencement of which in the case of the Association in fields such as brazing and the construction of arc-welded machinery has been made possible by application of Foreign Operations Administration funds from the United States. In

the ensuing replies the work of Sir William Larke, spanning from the inception in 1936 of the Welding Research Council on through the formative years of the Association, was warmly acknowledged on the occasion of his retirement as president.

As in former years, an exhibition of work in progress was arranged. Illustrative examples of current metallurgical work were housed in the partly completed new laboratory, since the metallurgical staff is being transferred from Park Crescent, London, to Abington this autumn.

Success in the production of strong and ductile fusion welds in high-strength aluminium alloys by means of the tungsten-arc process depends strongly upon the provision of filler material of correct composition when diluted with parent material. Performance with different compositions may be shown by means of a cracking test, in which shrinkage restraint is varied along a butt weld by means of symmetrical slots of graded length transversely cut into the parent plate at intervals along the weld. The test plate thus has the appearance of a fishbone, and with unsatisfactory conditions longitudinal weld-cracking occurs in the region of greatest restraint. The fusion welding of cylindrical fatigue specimens with the use of filler rods developed in this way was demonstrated.

In the case of the self-adjusting arc process, the arc is struck between the end of the filler rod and the plate, and the rod is advanced at a fixed speed to neutralize its own fusion. This process, although markedly successful by virtue of the results achieved and the simplicity of the control equipment, leads to some limitation in the ranges of voltage and current which may be successfully used, irrespective of the diameter of the filler wire through which the current is passed. Investigations undertaken co-operatively by the Electrical Research Association and the British Welding Research Association have shown experimentally that there are three different characteristics of arc operation and metal transfer, depending upon arc voltage. Thus, at low voltages discrete droplet transfer leads to irregular metal deposits unsuitable for welding. Above this voltage, in the practical working range, a spray transfer operates. At even higher voltages the spray transfer is accompanied by such high metal velocities that a strongly scouring action occurs in the molten pool, and unwanted complete penetration of the plate may take place. Nevertheless, in the working range, the somewhat lower spray-transfer velocity may be put to good use when welding in positions other than the horizontal. From the point of view of arc characteristics, the change from droplet to spray transfer is interesting because of the sudden change of current accompanying it.

The use of carbon dioxide as a shielding gas for arc welding of ferrous materials is of much topical interest, and typical welds made with this process were on view. In the case of other welds made with a mixture of argon and oxygen as shielding gas, unwanted porosity has been found and is thought to be associated with a reaction between carbon in the steel and gas which is either trapped or dissolved. Such porosity ought to be avoidable with sufficient added silicon in relation to carbon present in the fused metal. The manner of estimation of the requisite silicon content of the filler material was demonstrated.

Successful welding of metals such as titanium and zirconium is dependent upon the exclusion of reacting gases such as oxygen and nitrogen, for which these metals have great affinity. Welds of high quality for standardization purposes may be made in a completely closed argon chamber. In the apparatus which was shown, a sufficient degree of purity of the arc atmosphere is ensured by the production of high vacuum before flooding with argon.

Although it would be undesirable to claim that metallic titanium had not previously been cut successfully with an oxygen jet, predictions of feasibility were made by a member of staff of the Association as a result of earlier fundamental work on combustion in gas cutting. This was strikingly confirmed by experiment, and expectations of a high optimum cutting-speed, five times that for steel, were realized. Surface embrittlement, which was expected to arise from gas contamination, was not found to be as serious as anticipated, probably because of the high speeds. A practical demonstration of such cutting on moderately heavy sections was witnessed by visitors.

With regard to engineering activities, a further building frame was on view, after test to the point of plastic collapse by investigators under Prof. J. F. Baker, from the Department of Engineering in the University of Cambridge. This particular frame contained two stories, and illustrates the progress which has been made in bringing more complex constructions within the scope of load calculations for plastic collapse. The Association has gained much benefit from its financial support of this work.

Experimental stress analysis of elements of welded pressure vessels continues to fulfil an industrial requirement. The very thick pressure vessel containing circular nozzle openings, a model of which was shown last year, is shortly to be installed. The addition of reinforcement to reduce stress concentrations at its openings has been demonstrated theoretically to be unnecessary, and economy would ensue if this could be proved experimentally. At the opposite extreme, accumulated theory suggests that reinforcement may have to be substantial for large circular openings which are likely to be in use in thermal reactor vessels, because of the low ratio of shell thickness to diameter in such cases.

Stress analysis of vessels with openings has also been supplemented by pulsating pressure fatigue tests, from which the former work has been well vindicated. Fracture in some of the cases shown was directly associated with the calculable stress concentrations due to the openings themselves, rather than to unpredictable local stress concentrations induced through sharp changes of section at weld profiles.

In the fatigue laboratory, further results were presented from tests of high-quality butt welds in mild steel made by various welding processes. Recent work has also been addressed to a definition of the influence on fatigue strengths of various weld faults. Although, in the case of pipe butt welds, reductions of strength from all faults may be observed, the overriding effects of cracking and lack of penetration have been readily demonstrated. In comparison, the influence of moderate amounts of totally enclosed porosity appears to be reasonably small.

Determination of the fatigue resistance of all but the smallest welded shafts may be extremely slow if it is necessary to use a rotating-bending testing machine. In this respect, a resonance machine with a single unbalanced rotating mass, co-axial with the fixed shaft, enables an increased speed of testing to

be used, with the same stress cycle and a reasonably small power-input. It is later hoped to build an apparatus of greater load capacity than that which was on view.

In the pulsating pressure fatigue testing of welded joints in thick steel tubes, fluid pressures of many tons per square inch must be applied. A machine for this purpose, developed at the University of Bristol, was shown in use. A characteristic of the machine is the reduction of fluid volume to the greatest possible extent, whereby the energy stored at each pulsation may be reduced to low values.

Although the use of ultrasonic inspection for weld flaws may increase markedly in future thick welded constructions, it has first been necessary to achieve reliable calibration with regard to the strength of echoes. In this respect, the use of standard reference blocks was demonstrated, by means of which an apparatus may be quickly calibrated. Equal attention is now being given to attenuation of pulses by virtue of different surface contours in contact with the ultrasonic probes, in conjunction with various fluid coupling agents.

During the past year, experimental work on the brittle-fracture strengths of welded mild-steel plates has been continued with the 700-ton tension test rig, which was on view together with the fractured specimens. It is now believed that the role of residual stress in promoting fracture is better understood. While these stresses have no embrittling influence of themselves, it has been shown in the presence of a notched weld parallel to the direction of tension, and notch brittle parent material, that the static strengths of wide plates may be reduced to low values, such as are normally present in structures. When the residual stresses are removed, yield point stresses may be consistently sustained before fracture takes place. Thus, it is now believed that the beneficial effect of stress-relieving of welded structures may be more readily assessed.

UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1954–55

CONTRARY to the past few years, the "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1954–55", issued by the University Grants Committee*, show an increase of 1,103 in the number of full-time students; the latest figure is 81,705, compared with 80,602 in 1953–54, 81,474 in 1952–53 and 83,458 in 1951–52, and it is expected that the numbers in 1955–56 will show a further and greater increase, as it is known that there were 3,378 more full-time students in the autumn term of 1955 than in that of 1954. In the English universities, full-time men students increased by 395 and women by 500; for Wales, the corresponding figures were 46 and 17; and for Scotland, 61 and 84. There were 4,987 full-time and 2,010 part-time students from overseas within the British Commonwealth and 3,617 full-time and 1,594 part-time students from foreign countries; for 1953–54 the corresponding figures were 4,607 and 1,819 for the Commonwealth and 3,373 and 1,379 for foreign countries. There was no significant change in the distribution of full-time students among the faculties; but there were small increases both for science and technology: from 21·1 to 21·2 per cent for the former, an increase from 16,971 to 17,327, and from 12·4 to 12·9 per cent for the latter, an increase from 10,036 to 10,586. Full-time advanced students of pure science increased by 45 to 3,335, those of technology by 74 to 1,455, of agriculture by 17 to 307, and of veterinary science by 6 to 18, while those of medicine decreased by 49 to 813. Of the full-time advanced students, 2,835 (or 23·2 per cent) were working for the teacher's diploma. Of the full-time students, 64,778 were reading for a first degree, 4,099 for a first diploma and 12,212 were engaged in research or other advanced work, the corresponding figures for 1953–54 being 63,560, 4,350 and 12,166.

The proportion of assisted students was 72·9 per cent compared with 71·9 per cent in 1953–54; for England as a whole it increased from 74·2 to 74·9 per cent, but for Scotland it increased from 56·8 to 59·5 per cent, and for Wales decreased from 88·5 to 86·6 per cent. The dependence on parliamentary grants was practically unchanged, the £25,059,434 received from this source representing 70·4 per cent of the total income compared with 70·5 per cent in 1953–54. Of the recurrent income, 10·7 per cent came from fees, 4·1 per cent from endowments, 3·2 per cent from local authority grants and 1·1 per cent from donations and subscriptions, the corresponding figures for 1953–54 being 12·0, 4·3, 3·6 and 1·6 per cent, respectively. Universities were asked to show separately for the first time in 1954–55 income from grants for research and income receivable under research contracts: for England the former amounted to £1,079,307 and the latter to £685,615; for Wales the corresponding figures are £17,787 and £8,213, and for Scotland £115,308 and £45,683. The ratio of staff to students again improved, the full-time teaching staff being now 9,810, compared with 9,514 in 1953–54. The distribution of this increase among staff is: professors, 43; readers, assistant professors and independent lecturers, 36; senior lecturers, 41; and lecturers, 176.

Of the full-time students, 63,068 were in England (15,121 at Oxford and Cambridge, 18,201 at London and 29,746 at other universities and university colleges), 4,494 in Wales and 14,143 in Scotland. Except at Liverpool and at Reading, where there were decreases of 1 and 10, respectively, the increase in students was distributed over all the universities and colleges, but only at Oxford (150), Southampton (137), Durham (139), Leeds (128), St. Andrews (114) and Cambridge (104) did the increase exceed a hundred, though the increase by 95 to 719 at the Manchester College of Technology was the highest proportionate increase. The proportion of full-time students residing in colleges and halls of residence increased to 28·4 per cent; and, of these 23,243 students, 8,262 were at Oxford and Cambridge, 11,838 at other English institutions and only 1,261 in Wales and 1,882 in Scotland. The proportion of men in residence was 24·2 per cent, and of women 41·3 per cent, while 34,548 students (42·3 per cent) were in lodgings and 23,914 (29·3 per cent) at home, compared with 40·9 per cent and 31·0 per cent, respectively, during the previous year. Of the 22,463 students admitted for the first time during 1954–55 (an increase of 1,310 on 1953–54), 20,946 were reading for a first degree and 1,517 for a first diploma; of those reading for a first degree, 1,233

* Universities Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant for the Academic Year 1954–1955. (Cmd. 9800.) Pp. 50. (London: H.M.S.O., 1956.) 2s. 9d.

were under eighteen years of age and 11,843 were nineteen or more. Of the full-time students, 35,723 out of 47,793 men and 11,528 out of 15,275 women in England were receiving assistance by way of scholarships, exhibitions or other awards from public or private funds; for Wales the corresponding figures are 2,726 out of 3,187 men and 1,166 out of 1,307 women; and for Scotland, 6,331 out of 10,315 men and 2,089 out of 3,828 women. Of the 61,295 full-time men students, 36·1 per cent were in arts, 22·3 per cent in pure science, 16·6 per cent in medicine and 17·0 per cent in technology; for the 20,410 women students the corresponding figures are 63·7, 18·0, 14·4 and 0·7 per cent, respectively. Medicine and dentistry claimed 52·2 per cent of the part-time advanced students, arts 34·9 per cent, pure science 9·2 per cent and technology 2·7 per cent, compared with 49·6, 35·6, 9·3 and 4·8 per cent, respectively, during 1953–54.

The recurrent income of the universities and university colleges of Great Britain increased by £4,488,054 to £35,600,078, of which £25,059,434 was from parliamentary grants, £3,815,306 from fees, £1,448,212 from endowments, £1,140,643 from local authority grants and £401,379 from donations and subscriptions. Of the total income of £26,200,007 from public funds and £9,400,001 from other sources, the University of London received £7,803,937 and £2,748,652, respectively, while the figures for other universities were Cambridge £1,659,067 and £1,371,494; Oxford, £1,489,853 and £780,791; Manchester, £1,293,893 and £321,976; Leeds, £1,107,057 and £350,586; Birmingham, £1,069,933 and £438,788; Durham, £1,152,240 and £369,320; Liverpool, £1,057,395 and £320,826; Bristol, £825,567 and £430,386; Sheffield, £710,398 and £186,487; Nottingham, £568,488 and £148,410; and Reading, £624,686 and £93,438. No other English university or university college had an income exceeding half a million pounds; but for the four universities in Scotland the incomes from public funds and from other sources were Aberdeen, £576,117 and £138,690; Edinburgh, £1,235,533 and £415,402; Glasgow, £1,229,990 and £397,244; and St. Andrews £612,090 and £129,357. The University of Wales, including the Welsh National School of Medicine, received £1,326,200 and £336,405.

Of the recurrent expenditure of £34,791,656, an increase of 15 per cent on 1953–54, administration accounted for 7·2 per cent, departmental maintenance 69·3 per cent, maintenance of premises 12·0 per cent, and miscellaneous expenditure 10·2 per cent. Departmental maintenance, which includes salaries of teaching staff, payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of books, specimens, materials, apparatus, etc., increased by £2,095,004 to £24,100,985 and expenditure on maintenance of buildings increased by 8·2 per cent. Salaries and superannuation amounted to £15,958,695, compared with £13,616,426 in 1953–54, the increase being 17·2 per cent for teaching staff and 14·8 per cent for technicians and laboratory assistants.

Library expenditure, excluding general maintenance of library buildings, rates, heat, light, repairs, etc., amounted to £1,352,244, or 3·8 per cent of the total expenditure, compared with 4·0 per cent in 1953–54 and 3·9 per cent in 1952–53. Of this total, £707,236 was for salaries and wages, £154,963 on periodicals and £101,885 on bindings. Of the £310,102 expended on books, £72,939 was in the schools and colleges of the University of London, including £12,192 at the Central Library, £6,183 at the London School of Economics, £9,273 at University College, £5,153 at the School of Oriental and African Studies and £4,909 at Bedford College. The University of Oxford spent £31,585 on books; Cambridge, £22,796; Manchester, £21,559; Liverpool, £11,608; Leeds, £10,116; Durham, £12,993; Birmingham, £10,215; and Bristol, £9,553. Only the Universities of London (£44,813), Oxford (£14,948) and Cambridge (£12,233) spent more than £10,000 on periodicals, and only Birmingham (£7,200), Leeds (£5,855) and Manchester (£6,458) more than £5,000. The University of Wales spent £14,789 on books and £8,457 on periodicals. In Scotland, Edinburgh spent £15,087 on books and £6,813 on periodicals; Glasgow, £11,662 and £7,382; St. Andrews, £11,856 and £4,702; and Aberdeen, £8,333 and £3,954.

INSTITUTE OF PHYSICS

REPORT FOR 1955

THE thirty-sixth annual report of the Board of the Institute of Physics*, which was presented to the annual meeting of the Institute in London on July 16, indicates the growing importance of the work of the Institute and the increasing number of physicists now being employed in industry, teaching and research. The total membership rose during the year under review by 397 to 5,146, reaching the five thousand mark for the first time. There were increases in all the grades of membership, with substantial increases in the associateship and graduateship grades. 726 applications for election or transfer to the various grades were received during the year, compared with 579 during 1954. Eleven of the fifty-four candidates who took the examination for graduateship of the Institute were successful. The numbers of candidates for the final examinations for the National Certificate in Applied Physics were 309 for the ordinary level and 82 for the higher, compared with 206 and 75, respectively, in 1954.

The report mentions that representatives of the membership committee visited seven technical colleges which had applied for official recognition, or extension of recognition, by the Board as institutions suitable for training of physicists in accordance with the Institute's membership regulations. The degrees of the University of Malaya were also recognized by the Board. The report of an inquiry by the Board into the availability of places for students of physics in the universities and larger technical colleges of Great Britain was published by the Institute in its September *Bulletin*, and reprints have since been widely circulated. Many requests continue to be received from those leaving school and others concerning careers in physics, and the deputy secretary of the Institute, Mr. N. Clarke, has addressed meetings on this subject in Aberdeen, Bristol, Edinburgh, Ewell, Glasgow and Swansea. The Institute has kept in close and constant touch with the permanent officers of the American Institute of Physics and has made a joint inquiry with the Physical Society, London, about the likely demand for English translations of Russian papers on pure and applied physics.

* Thirty-sixth Annual Report of the Board of the Institute of Physics, 1955. Pp. 18. (London: Institute of Physics, 1956.)

The need for a recognized permanent body in Great Britain before which papers on the application of nuclear energy and ancillary subjects could be read and discussed was the subject of negotiations initiated by the major engineering institutions, and as a result a body known as the British Nuclear Energy Conference was formally inaugurated at a meeting in London on November 30. The Institute of Physics and the Institutions of Civil, Mechanical, Electrical and Chemical Engineers are the founding constituent bodies, and each has three representatives on the governing board.

Details of the various activities of the nine branches and seven specialist subject groups of the Institute are briefly referred to in the report. There are eight local branches in Great Britain, and also an autonomous Australian Branch, under the presidency of Prof. L. G. H. Huxley, with divisions in the different States. During November 22–24 an exhibition of scientific instruments and apparatus was held by the Australian Branch and was well attended. The Liverpool and North Wales Branch held its inaugural meeting on May 19, 1955, in the Department of Electrical Engineering of the University of Liverpool, and the inaugural lecture was delivered by Prof. Z. Kopal, professor of astronomy in the University of Manchester, who took as his subject "The Physics of the Sun" (published in *Brit. J. App. Phys.*, **7**, 119; April 1956). The Scottish Branch, in addition to holding meetings in Glasgow, Edinburgh, Aberdeen and Dundee, arranged a course of five lectures on computers, and a conference on the training of physicists for industry was held by the Yorkshire Branch at the Rotherham Technical College on April 21. The two main subjects for discussion at the annual conference of the Education Group during April 14–15 were the teaching of thermodynamics and the place of physics in a liberal education; the Electronics Group held a symposium on recent developments in magnetic materials, and the X-ray Analysis Group has continued its work, under the direction of Prof. A. J. C. Wilson (University College, Cardiff), on the provision of data for the index of diffraction patterns which is published by the American Society for Testing Materials.

Both the circulation and the advertisement revenue of the Institute's two monthly periodicals, the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, increased satisfactorily during the year; unfortunately, costs of production continued to rise. The amount of material submitted and published in 1955 was similar to that in 1954; but as more papers were published than accepted, the average delay between submission and publication of acceptable manuscripts was reduced slightly. The fourth supplement to the *British Journal of Applied Physics*, containing the proceedings of the Electronics Group's symposium held in Cambridge, 1954, on luminescence with particular reference to inorganic phosphors, was published as part of the 1955 volume. The twelve monthly issues of the Institute's *Bulletin* (issued to members only) contained fourteen articles, some of them invited contributions and others based on lectures given to the Education Group. The *Bulletin* is appearing in a new and improved form this year. In the "Physics in Industry" series, two new volumes—"X-ray Diffraction by Polycrystalline Materials" containing contributions by thirty-one members of the X-ray Analysis Group, and "Physics of Fibres" by H. J. Woods—were published during the year, and three booklets in the "Student Monograph" series were issued.

At the general meeting of the Institute the following were elected to take office on October 1: *President*, Mr. O. W. Humphreys; *Vice-President*, Dr. B. P. Dudding; *Honorary Treasurer*, Dr. J. Taylor; *Honorary Secretary*, Prof. F. A. Vick; *New Ordinary Members of the Board*, Dr. L. R. G. Treloar and Mr. G. W. Warren. Sir George Thomson, master of Corpus Christi College, Cambridge, was elected to honorary fellowship in recognition of his outstanding contributions to physics and his services to physicists.

HIGH CLOUD OVER SOUTHERN ENGLAND

A SUBSIDIARY task of the Air Ministry Meteorological Research Flight is the making of observations of cirrus clouds, the white ice-crystal clouds, called popularly 'mare's tails' in one form, which are the highest clouds ordinarily visible. The rarely seen mother-of-pearl and noctilucent clouds are much higher. R. J. Murgatroyd, chief meteorological officer of the Flight, discusses these observations in Professional Note 119 of the Meteorological Office*.

Cirrus clouds are not easily studied in flying through them, because often they are so tenuous that the observer finds it hard to tell when he has reached a cirrus cloud clearly seen from far below. The tops, however, are more sharply defined than the bases. It was found that cirrus cloud is almost always entirely within the troposphere, though the tops are often only just below the tropopause. On a few occasions reported in the note, 'cloud' was seen in the stratosphere; but it is known that the observations in July and August 1953, which constitute the majority, were actually of volcanic dust produced by an eruption in Alaska on July 7. The heights of the tops were usually within 2,000 ft. of the tropopause, and the lower the tropopause the closer the cirrus tops were to it. Cirrus, which looks so thin from the ground, is usually between 3,000 and 5,000 ft. thick, and may be as much as 12,000 ft. thick.

An important feature when cirrus clouds were visible was a moist layer extending downwind from them at the same level, which became more pronounced (depression of frost point below dry bulb decreasing) as the clouds were approached. The humidity in the clouds seems to be surprisingly low. The depression of the frost point ranged from 12 to −2 deg. F., with a mean depression of about 3 deg. F. This average value corresponds to about 80 per cent relative humidity with respect to ice and, since the saturation vapour pressure is higher over water than ice, a markedly lower one (50 per cent) with respect to water, which is remarkable if it is correct that saturation with respect to water is necessary for the formation of cirrus cloud. The presence or absence of cirrus is a useful guide to the fighter pilot as to whether his aircraft is likely to produce a marked condensation trail, as it was found that, when cirrus was present, the probability of making a very persistent condensation trail was roughly about twelve times (60 per cent of flights) the probability (only 5 per cent of flights) when it was not.

* Air Ministry: Meteorological Office. Professional Note No. 119: High Cloud over Southern England. By R. J. Murgatroyd and P. Goldsmith. Pp. 20. (M.O. 524 *S.*) (London: H.M.S.O., 1956.) 9*d.* net.

CRETACEOUS AMMONITES OF WEST AFRICA

CRETACEOUS ammonites have long been known from many parts of West Africa, and some of the faunas, notably those of Angola, have been the subject of substantial works. Apart, however, from descriptions of Turonian and Coniacian faunas from the Mungo River, comparatively little has been published about the Cretaceous ammonites of Nigeria. With the publication, however, of Dr. R. A. Reyment's "Cretaceous Ammonoidea of Southern Nigeria and the Southern Cameroons"*, we have for the first time a comprehensive monograph of the material from considerable areas of the country. Dr. Reyment figures about 135 species and sub-species, many of them new, ranging in age from Middle Albian to Maestrichtian. He supplies a great deal of new information of both palæontological and stratigraphical importance.

The Albian faunas consist mainly of keeled ammonites of the Mortoniceratidae, most of them species already described from Europe, Angola, Zululand or Madagascar. The puzzling genus *Neokentroceras*, characterized by exceptional tuberculation in the small specimens which alone had been figured, is now shown to have outer whorls like those of many typical members of Mortoniceratinae, in which subfamily it must now be placed. One most surprising discovery was that of a new species of *Gyaloceras*, an inflated genus of Aconeceratinae, which was previously reported only from Queensland. Like most of the other genera of this subfamily of Oppeliidae, it will probably turn out to have a wide range.

The Nigerian Cenomanian has yielded few ammonites, but the Lower Turonian has produced abundant ammonites of great interest. These include, in particular, a wide range of genera and species representing the burst of radiation from the Acanthoceratidae which characterized the early Turonian. Much light is thrown on the relationships of some genera that have been long but ill known. In addition, there are full descriptions of a number of new genera and sub-genera which fill in gaps in the story of this burst of radiation.

Most of the known forms of the families Tissotiidae and Vascoceratidae (two of the groups derived from Acanthoceratidae) characterize the deposits of the Tethys, the Cretaceous 'Mediterranean' and tropical sea, and it has been impossible to work out any accurate correlation with more northerly Turonian, characterized by other families of ammonites. Special interest therefore lies in Dr. Reyment's discovery, in association with *Hoplitoides* and *Neoptychites*, of a few specimens of *Watinoceras*, a genus which occurs in North America, England, Turkestan and perhaps Japan, and is a valuable stratigraphic indicator.

The later ammonites include an interesting group of Coniacian species, some already described by Solger, and some small and unremarkable Santonian and Maestrichtian faunas.

The author makes a sensible use of subgenera and subspecies. Thus, while he describes all the distinct forms, he avoids that inflation of taxonomic scale which is a common and dangerous tendency on the part, particularly, of those who have to deal with abundant collections of well-preserved fossils of rapidly evolving groups. No doubt among the reasons for this welcome restraint is the fact that the author is a member of the Geological Survey of Nigeria, in close touch with the field staff, and also has himself collected a large part of the material he describes.

The monograph is very well produced, admirably illustrated both with plates and line-drawings and written with a refreshing clarity and absence of 'ammonite jargon'. It will be of particular value to all who work on the African Cretaceous; but, as already indicated, its interest and importance extend far more widely.

C. W. WRIGHT

* Reyment, R. A., "The Cretaceous Ammonoidea of Southern Nigeria and the Southern Cameroons", Geological Survey of Nigeria, Bulletin No. 25, pp. 112+25 pl., 46 figs. (Lagos). 20s.

PROTEIN METABOLISM, RESPIRATION AND GROWTH*

A SYNTHESIS OF RESULTS FROM THE USE OF ^{14}C-LABELLED SUBSTRATES AND TISSUE CULTURES

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Impact of Growth on Fresh Weight, Protein Metabolism and Respiration of Carrot Tissue Explants

The characteristics of the rapidly dividing cell might reside either in substances that are peculiar to the tissue treated with coconut milk or, alternatively, they may reside more in the *intensity* of certain processes than in their *nature*.

(* *Continued from p. 734*)

Therefore, one may ask whether the amino-acid composition of the protein in the rapidly dividing cells is different from that of the more resting cells. The amino-acid composition of the entire protein complement in the tissue was determined from the analytical data and the changes that occur with time may also be seen. To reveal the relative molar composition of the protein, the value of 10 was arbitrarily assigned to alanine. The composition of the protein under the different treatments and at

Table 4. Molar Amino-acid Composition of Protein in Fast- and Slow-growing Carrot Tissue Explants

(Rel. composition based on alanine = 10)

Amino-acid	Slow-growing tissue (no coconut milk)	Fast-growing tissue (+ coconut milk)
Aspartic acid	10·3	10·2
Glutamic acid	11·1	11·2
Serine	8·3	7·2
Glycine	11·2	12·8
Threonine	8·3	7·4
Alanine	10	10
Valine	8·3	7·2
Leucines	12·2	11·2
Lysine	3·6	5·6
Arginine	1·8	3·1
Proline	15·6	12·7
Hydroxyproline	9·8	4·5

the different times of sampling was strikingly similar, so much so that these were all pooled, and mean values calculated for all the tissues treated with coconut milk, irrespective of the radioactive substrates, and for all the tissues not treated with coconut milk. These data are summarized in Table 4. Thus, although the treatment with coconut milk had a very great effect on the *quantity* of protein in the tissues, this seems to occur without great effect upon its *amino-acid composition*.

Some differences are to be seen in these analytical data. Cultured carrot tissue, like cultured potato tissue, differs from the resting tissue in the intact organ in that it contains hydroxyproline in unexpectedly large amounts in the protein[15]. The significance of this is not yet known. Also, the protein of the fast-growing tissue probably contained relatively more glycine, lysine and arginine, while the protein of the slow-growing tissue contained somewhat more serine, threonine, valine and leucine in addition to proline. However, recognizing the great difference in biological activity of these two systems, the differences in protein composition seems small, and work on purified proteins would be required to establish that the fast-growing cells had a protein of characteristic amino-acid composition.

The total protein of the dividing cells seems to be richer in the basic amino-acids than that of the non-growing cells and in this resembles the bulk protein of certain plant growing points[16]. However, according to Easty and Ambrose[17], the amino-acid composition of the protein of kidney cells and of neoplastic tissue derived from them differ but little, and these authors ascribe the difference in their proteins to other features than the overall amino-acid composition.

What then does the coconut milk stimulus do? By measuring the effect of the coconut milk on various properties of the tissue one may see where it exerts its effect. To do this the value of the property in question as for the fast-growing tissue is expressed as a ratio to the similar quantity for the slow-growing tissue. This has been done for the following properties: (1) the incorporation of fresh weight by water absorption as the tissue grows; (2) the overall synthesis of total protein; (3) the total respiration per explant as measured by carbon dioxide production; (4) the rate of incorporation of carbon-14 activity into a variety of amino-acids both free and combined.

Some of the results are shown in Table 5. These lead to the following comments:

(1) There is a remarkable similarity in the acquisition of fresh weight and of total protein by the tissue stimulated to growth by coconut milk. This means that the acquisition of water by the growing cells is not merely osmotic in nature but is closely linked to the metabolism with which protein synthesis is concerned. In these tissue cultures stimulated to rapid growth, the increment of fresh weight should not, therefore, be considered merely as passive osmotic water absorption but rather that the water is actually being built into the structure of the cells and is as integral a part of its growth as the increment of total protein. This aspect of water absorption is, indeed, not new. Many recent papers since that of Bennet-Clark *et al.*[18] have stressed the fact of non-osmotic and metabolically activated water absorption by cells, and one of us earlier stressed that water uptake, salt accumulation, protein synthesis and a particular part of the aerobic respiration all were determined by similar variables in potato tissue slices which retained the ability to grow (ref. 13, cf. p. 415).

(2) The stimulus to the growing cells accentuated their total respiration much more than it accentuated their growth as measured by fresh weight or total protein. This disparity is shown by the ratios 3·7 and 5·1. Thus, the protein of the growing cell does not merely support respiration in accordance with its total mass; but, under the coconut milk stimulus, a given weight of protein is *much more effective in maintaining respiration*.

(3) In the incorporation of radioactive carbon into specific amino-acids of the protein there are evident effects of two kinds. These are illustrated, on one hand, by the amino-acids glutamic acid, aspartic acid and threonine and, on the other, by proline and hydroxyproline. In all these cases substantial amounts of radioactivity were incorporated in the amino-acids of the protein from the substrates supplied. In one type of situation, illustrated by proline and hydroxyproline, the increased incorporation of radioactivity into these amino-acids caused by coconut milk is approximately measured by the increased *total* synthesis of protein which occurred. (Whereas fresh weight and total protein were stimulated 3·7 times by the coconut milk treatment, the incorporation of proline and hydroxyproline was also stimulated about three times. The incorporation of carbon-14 in the proline and hydroxyproline of the protein was also stimulated about three times.) The other amino-acids, however, behaved quite differently because the incorporation of radioactivity from their substrates into these amino-acids in the protein was stimulated by the coconut milk treatment *far in excess* of the stimulus to total protein synthesized. However, the effect of coconut milk in stimulating incorporation of carbon-14 into the amino-acids glutamic, aspartic and threonine of the protein is the

Table 5. Impact of Growth on Fresh Weight, Respiration and Protein Metabolism

Relative increase due to growth = ratio of (*a*) fresh weight, (*b*) total protein, (*c*) respiration, (*d*) ^{14}C-activity in protein amino-acids of the fast- to the slow-growing tissue

(All data refer to Period 5 (85–109 hr.))

Property	Fresh weight	Total protein	Total respiration	^{14}C-activity in protein amino-acids: Glutamic acid	Aspartic acid	Threonine	Proline	Hydroxyproline
Ratio fast growing / slow growing	3·7	3·7	5·1	5·6	4·6	5·2	3·9	2·0
					5·2		3·0	

same as the degree of stimulus conveyed by the coconut milk to the total respiration.

This close relation between respiration and the latter amino-acids is derived from their origin from carbon skeletons, formed by glycolysis or the tricarboxylic acid cycle, and the incorporation of their carbon into protein—this incorporation proceeding more readily from glucose than from free amino-acids. The connexion between respiration and the endergonic processes of assimilation and synthesis is now well established from work with higher plants and micro-organisms. Ways in which respiration may be regulated, through its coupling with phosphorylation and oxidation-reduction, have been considered with particular regard to the synthesis of protein[19,20]. For the system now under consideration, another connexion between respiration and protein metabolism may be visualized, as shown in Fig. 1.

Part of the respiration varies with the rate of protein turnover. Part of the carbon dioxide of respiration originates from protein which is broken down, and thus the pace of alternating protein synthesis and breakdown will determine the extent of carbon dioxide that emerges by this route (phase 2 of Fig. 1). It is this component of the respiration which may be greatly stimulated in the fast-growing tissue, so that the apparent efficiency of the protein contained in the tissue to produce carbon dioxide, as shown by the ratios in Table 5, is much greater than the slow-growing tissue.

Thus, one may visualize the total bulk of protein as consisting essentially of two moieties. One element of the protein remains relatively steady; the other actively undergoes alternating synthesis and breakdown, and, in this latter sequence, it is linked with part of the respiration as measured by carbon dioxide production. This means that a part of the carbon which emerges as carbon dioxide may do so after it has been built into the protein molecule. Moreover, from the other data referred to, it is apparent that *the incorporation of carbon in the protein molecule proceeds much more readily from glucose than from the free amino-acids of the tissue.*

On the other hand, some free amino-acids do incorporate their carbon directly into at least certain of the proteins (for example, proline and hydroxyproline); but it appears that the particular protein moieties which are synthesized in this way represent proteins which are not in a metabolically active state of synthesis and breakdown but which, once formed, seem to constitute metabolically a 'point of no return'. Whereas the specific activity data clearly show that the proline of the protein could be embodied directly from the free proline in the cell, it is quite apparent that this could not occur with aspartic acid, glutamic acid, etc., for the specific activities of these substances in the protein bear no relationship to the specific activities of the substances as they occur free in the cell.

Respiration, Protein Synthesis and Breakdown: Some Parallel Situations

Older views of Warburg, recently revised[21,22], would have it that the rapidly dividing, or cancerous, cell has its fermentation stimulated to the point where it can obtain enough usable energy in the form of adenosine triphosphate to suffice for growth by cell division, whereas the normal cell can only achieve these ends through oxidative respiratory mechanisms. If this is so, though it is not accepted without question[23], it would not appear in the present work.

The present investigations lead to a different concept of the randomly proliferating plant cell. In the growing cells there are apparently several routes by which carbon dioxide can emerge. The familiar glycolytic–Krebs cycle pathway and its alternative, the gluconic acid shunt, may all apply to some extent. In the rapidly growing cells, however, it is necessary to recognize the interaction of protein metabolism and respiration because the carbon which enters into metabolically active protein now appears to emerge through protein breakdown, the release of amino-acids, the formation of amides, the deamidation and deamination of these substances to produce carbon skeletons which may be oxidized away to form carbon dioxide. Such carbon skeletons may enter the Krebs cycle as alternatives to the products of glycolysis[13]. Overall, this can result in the incorporation of carbon from sugar into protein and its eventual emergence as carbon dioxide; but the pace of this process may be conditioned by the pace of alternating synthesis and breakdown of the metabolically active moiety of the protein.

The peculiarity of the stimulus to rapid cell division, caused by the coconut milk growth factors, is that it not only enriches the protein content of the cells as a whole but it may also increase, in a disproportionate way, the importance of the protein turnover and of the associated respiration.

In this connexion it is of interest that Vrba[24] has re-emphasized the role of protein breakdown and resynthesis in brain during muscular exercise. Not only is there seen to be an accentuated turnover of protein in a "cyclical process of degradation and resynthesis of the protein fraction of brain nervous tissue" but "during this process free glutamine is formed from the free glutamic acid, which is simultaneously an initial link for the phase of resynthesis". The parallel is clear.

By contrast the less-active moiety of the tissue protein, which once formed does not break down again, is only affected by the growth stimulus in the proportion that the total protein is increased and to the same extent that cell number and fresh weight are also increased.

Thus the rapidly dividing, proliferating, tumorous-like cells of these rapidly growing tissue cultures stimulated by coconut milk stand in sharp contrast to many viruses. These, and particularly tobacco mosaic virus, divert the protein metabolism of the host cell into the synthesis of virus protein which, once formed, is not reincorporated into metabolism. It constitutes, therefore, a "point of no return" (see ref. 15, p. 553, for references there cited). The coconut milk, however, stimulates that moiety of the protein which is metabolically active and which, through alternating synthesis and breakdown, can contribute to the total respiration and energy exchanges for the physiological use of the growing cell.

The stable, metabolically inactive protein moiety which does not 'turn over' may have more than merely structural properties. This fraction could possess and exert enzyme activity, and indeed there are many other indications that enzyme activity is unequally divided between different kinds of protein fraction to be found in cells.

Final Conclusions

The value of plant tissue cultures used under conditions which contrast in the rapidly growing

and the slow growing states will now be evident. By recognizing and making use of the complications of growth and metabolism, conclusions can be derived that are unattainable if biochemical study is only upon systems which attempt to eliminate these complexities.

Much modern biochemistry is pre-occupied with cellular particles and particulate preparations. However, the study of metabolism in relation to growth, as here described, requires work on the whole cell to reveal the integrated operation of the whole system. Smuts's principle of "Holism"[25] applies here, for "The whole is not something additional to the parts: it is the parts in a definite structural arrangement and with mutual activities that constitute the whole" (loc. cit., p. 104).

In the use of radioactive substrates to reveal metabolic sequences it is therefore necessary to recognize the existence of separate phases or compartments in the cell and to recognize that in each of these, quite different reactions may involve simultaneously the same substrate; but it is also encouraging that these complications can be surmounted. The means to do this is to determine, for all available tissue constituents, not merely the existence of radioactivity in a given compound, not merely the specific activity of the tissue metabolite at a given time, but, by the investigation of time sequences, to make an estimate of the average specific activity of the carbon which must have been involved in the metabolic change that occurred. From the relations which these calculated results bear to the known specific activity of the source supplied, it is possible to appreciate the kind of complications that occur within the cell. Since this enables the investigator to recognize clearly that reactions occur in different compartments of the cell and to recognize that the total complement of a given constituent is made up of at least two different metabolic pools which do not mingle, this adds a valuable technique to the carbon-14 tracer method.

Even a relatively simple experiment, when planned to deal with all these complications, becomes a formidable task. To solve these problems, teamwork becomes essential, and this was happily achieved in the present case by pooling resources of personnel, equipment, technique and even substances synthesized from three different laboratories in three different countries.

It is too soon and perhaps too optimistic to suggest that the results here described could be applied directly to the investigations of cancerous growth in animal organs. The possibility, however, remains that the characteristic properties of the cancerous cell, like those of carrot cells stimulated by coconut milk, may lie not so much in distinctive substances and reactions as in accentuated rate of 'turnover' of their metabolically active, labile constituents owing to enhanced synthesis and breakdown. Investigations of nitrogen metabolism[26] in relation to cancer seem not to have considered this possibility. In plants this cyclical process may in part control the release of usable energy via a phase of respiration which is peculiarly linked with the ability of the cell to grow by cell division and to utilize metabolic energy for assimilation in such processes as water intake and salt accumulation. If these results have wider application, this pioneer experiment will indeed have been justified, and this general account will have achieved its purpose.

The full details of the work will be published elsewhere in due course.

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A SPECIFIC CHEMICAL DIFFERENCE BETWEEN THE GLOBINS OF NORMAL HUMAN AND SICKLE-CELL ANÆMIA HÆMOGLOBIN

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A NEW and rapid technique of characterizing the chemical properties of a protein in considerable detail has been devised; by its application a specific difference is found in the sequence of amino-acid residues of normal and sickle-cell hæmoglobin. This difference appears to be confined to one small section of one of the polypeptide chains.

Of all the abnormal human hæmoglobins, the one that has been most intensively studied is hæmoglobin *S* from patients with sickle-cell anæmia. In 1949 Pauling and his collaborators[1] demonstrated by electrophoretic experiments that at neutral *p*H the hæmoglobin *S* molecule has a net charge which is more positive by three units compared with the normal molecule, hæmoglobin *A*. It has since been suggested[2] that this difference is really due to hæmoglobin *S* having fewer free carboxyl groups than does hæmoglobin *A*. It is also known that in the reduced state the abnormal protein has a much lower solubility[3]. However, careful determinations of the amino-acid composition of the two proteins[4,5] did not show any significant differences between them within the accuracy of the methods employed. Comparison of the N-terminal[6] and C-terminal[7] amino-acids and of the sulphydryl groups[8] was equally disappointing. On this evidence alone, it is not possible to decide whether the difference between the proteins, which is in any event small, lies in the amino-acid

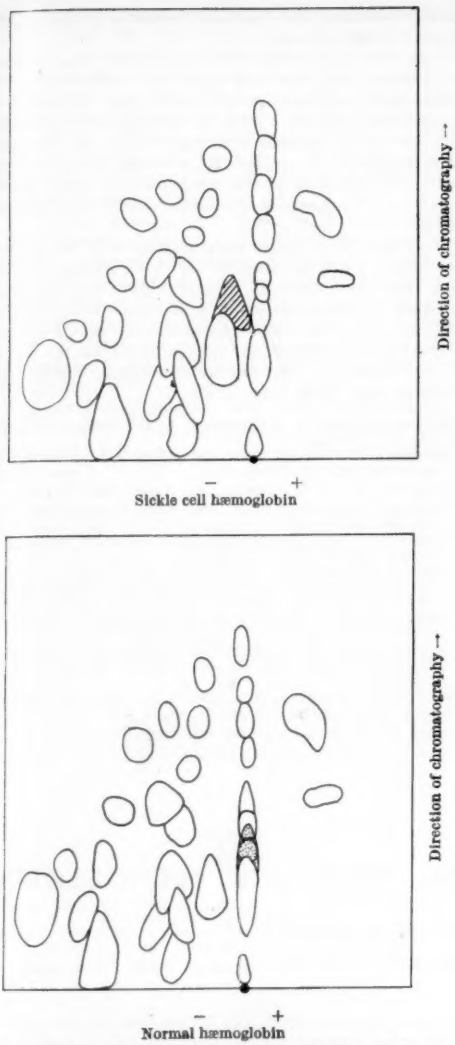

Fig. 1. 'Finger prints' of human normal and sickle-cell hæmoglobins. Electrophoresis at *p*H 6·4, chromatography with *n*-butyl alcohol/acetic acid/water (3 : 1 : 1). The shaded and the stippled spots are those belonging to the peptide showing the difference

sequences of the polypeptide chains or whether it lies in the folding of these chains leading to a masking of some amino-acid side-chains.

Hæmoglobin is still too large a molecule for detailed analysis of amino-acid sequence. However, it was thought that if a rapid method could be found of characterizing the chemical properties of the peptides in a tryptic digest, then perhaps a replacement of even a single residue for another might be detected without elaborate analysis.

The action of trypsin on proteins is at present the most reliable way of splitting a peptide chain at specific peptide bonds. The enzyme attacks only those bonds which are derived from the carboxyl group of the amino-acids lysine and arginine. There are about sixty of these in the hæmoglobin *A* and *S* molecules[5], but since it is expected[9] that each molecule is composed of two identical half-molecules, the number of peptides obtained by the action of trypsin should be about thirty, with an average chain-length of ten amino-acids. Small differences in the two proteins will result in small changes in one or more of these peptides. These should be detectable when the mixture is examined by a two-dimensional combination of paper electrophoresis and paper chromatography. It was decided to call the resulting chromatogram the 'finger print' of the protein.

To prepare such a 'finger print', samples of purified[10] hæmoglobins *A* and *S* were denatured by heat at 90° C. for 4 min. and digested with trypsin (2 per cent by weight) at *p*H 8 and 37° C. for 43 hr. Aliquots of these digests (equivalent to 3 mgm. of protein) were placed on large sheets of Whatman No. 3 *MM* paper between glass plates and subjected to electrophoresis[11] in pyridine/acetic acid at *p*H 6·4 for 150 min. at 16 V./cm. The paper was then dried. Ascending chromatography with *n*-butyl alcohol/acetic acid/water (3 : 1 : 1) and development of the peptide spots with ninhydrin produced the chromatograms shown in the tracings of Fig. 1. When the papers were run strictly in parallel, reproducibility was often good enough to superimpose the spots belonging to similar peptides in the two chromatograms.

The 'finger prints' show approximately thirty peptide spots, as was expected from the amino-acid composition. This confirms the view that the human hæmoglobin molecule consists of two identical half-molecules and not of four identical sub-units each carrying one of the four hæme groups. The same number of peptides was found for both hæmoglobins, as was to be expected from their containing the same number of lysine and arginine residues. Most of the peptides are well resolved, and appear to be similar in the two proteins. However, there is one peptide spot clearly visible in the digest of hæmoglobin *S* which is not obvious in the hæmoglobin *A* 'finger print'. In the tracing it has been marked by shading. Apart from its position, this peptide is characterized by its orange-colour reaction with

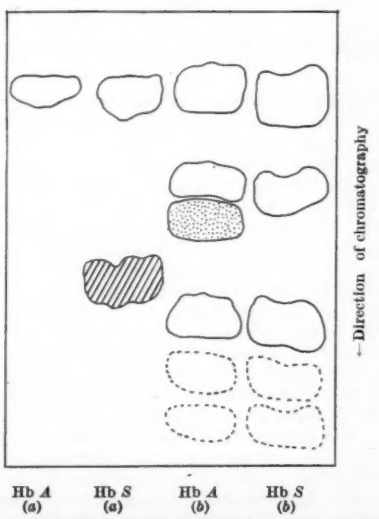

Fig. 2. Chromatogram of fractions of hæmoglobin *A* and *S* digests obtained by large-scale paper electrophoresis. (*a*) Slowest moving positively charged fractions; (*b*) neutral fractions

ninhydrin. Close inspection of the 'finger print' of hæmoglobin *A* shows the outline of an orange peptide spot in the 'back-bone' of neutral peptides which are not separated by electrophoresis. This spot, which has been stippled in the tracing, is not present in the neutral fraction of the digested hæmoglobin *S*. However, the neutral peptides are not really well separated by this two-dimensional technique.

Accordingly, larger amounts of the digests from both hæmoglobins were run in one direction only, using the electrophoretic conditions described earlier. Many bands were obtained. Both the band of neutral peptides and the slowest of the positively charged bands were eluted in each case, but separately. The eluted peptide mixtures were subjected to descending chromatography with *n*-butyl alcohol/acetic acid/water (4 : 1 : 5). Fig. 2 is a tracing of the chromatogram obtained showing the behaviour of the 'extra' or 'sickle cell' peptide in the two digests. This confirms that there is a particular peptide in the neutral fraction of the hæmoglobin *A* digest, which in the hæmoglobin *S* digest is shifted to the slowest positively charged zone. In addition, the R_F value of the hæmoglobin *A* peptide in the chromatographic solvent is lower than that of the analogous peptide derived from hæmoglobin *S*.

Summarizing the results of the electrophoretic and chromatographic examination, it can be seen that there is one peptide among the thirty or so which in hæmoglobin *S* is positively charged, but which is uncharged at the same *p*H in digests of hæmoglobin *A*. This agrees with the higher net positive charge[1] of the parent protein, hæmoglobin *S*. There is also a small change in the chromatographic behaviour of the peptide. On the other hand, corresponding pairs of all the other peptides show similar behaviour in these separating systems and therefore probably have similar constitutions.

One can now answer at least partly the question put earlier, and say that there is a difference in the amino-acid sequence in one small part of one of the polypeptide chains. This is particularly interesting in view of the genetic evidence[12] that the formation of hæmoglobin *S* is due to a mutation in a single gene. It remains to be seen exactly how large a portion of the chains is affected and how the sequences differ.

Full details of these experiments will be reported elsewhere. I am indebted to Dr. A. C. Allison (Oxford) and Dr. G. Seaman (Cambridge) for supplying samples of hæmoglobin *S* and blood from patients with homozygous sickle-cell anæmia; and I acknowledge the encouragement and interest shown by Dr. M. F. Perutz, and the expert assistance of Mrs. Leslie Barnett and Miss Rita Prior.

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IDENTIFICATION OF A NEW NORMAL EMBRYONIC HÆMOGLOBIN

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During a current study of the process of formation and appearance of the two hitherto known types of normal hæmoglobin, and of the different serum protein fractions of the fœtal blood throughout the various stages of embryonic life, we were able to examine the blood of a ten-week old embryo, recovered from an intact extra-uterine pregnancy. To the best of our knowledge this is the smallest human embryo of which blood chemistry data have been reported in the literature.

Using the method described by Singer[1] we found that the hæmoglobin of the ten-week old embryo consisted of 83 per cent of the alkali-resistant type.

The electrophoretic examination of this hæmoglobin was carried out in a Thomas paper electrophoresis apparatus on Whatman No. 1 filter paper using a veronal buffer solution of 0·04 ionic strength at 8·6 *p*H. In a 20-hr. run at 150 volts and 1·5 m.amp. per in. of filter paper a 3 per cent hæmolysate of this embryonic hæmoglobin, prepared by Drabkin's[2] method, showed a definitely slower mobility compared with the electrophoretic mobility of adult hæmoglobin used as control as shown in Fig. 1.

Later on we discovered an embryonic hæmoglobin with an identically slow electrophoretic mobility in the blood of a 20-week old fœtus weighing 450 gm. The concentration of the alkali-resistant type of hæmoglobin in this blood was 52 per cent. The electrophoretic mobility of the embryonic hæmoglobin was compared both with that of hæmoglobin recovered from cordal blood of a full-term newly born with approximately the same concentration of alkali-resistant fraction and with adult hæmoglobin. The hæmoglobin of the 20-week old fœtus showed a distinctly slower mobility as compared with both the newly born's cordal blood and the adult hæmoglobin. A mixture of the embryonic and the newly born's cordal blood hæmoglobins showed an electrophoretic mobility between both, as shown in Figs. 2 and 3.

The fact that, on one hand, the hæmoglobin of the embryonic and of the newly born's cordal blood, containing the same percentage of the alkali-resistant type of hæmoglobin, moved with different mobilities, and on the other hand, the hæmoglobins of the two embryos (Fig. 3, *a* and *c*), although differing substan-

tially in their concentration of the alkali-resistant fraction, had the same mobility, is of special significance. It indicates that the difference in the electrophoretic mobility of these two embryonic hæmoglobins on one hand, and the cordal blood hæmoglobin of the newly born on the other hand, is not due to different concentrations of the alkali-resistant hæmoglobin fraction. It is due to the presence of a different hæmoglobin in the red blood corpuscles of early embryonic life.

This third hæmoglobin may be identical with a new embryonic hæmoglobin for which Allison[3] has recently proposed the name of "primitive type P" of normal hæmoglobin. According to this author, the synthesis of this hæmoglobin seems to be under a different genetic control from that of the hæmoglobins of later fœtal life. This appears to have been definitely established for the early embryonic hæmoglobin of the mouse.

Further investigations are being undertaken in our laboratory to elucidate the characteristics of this new type of normal hæmoglobin. We are especially attempting to determine the process of its disappearance from the fœtal blood and the eventual pathogenic role of abnormal persistence of this hæmoglobin beyond embryonic life.

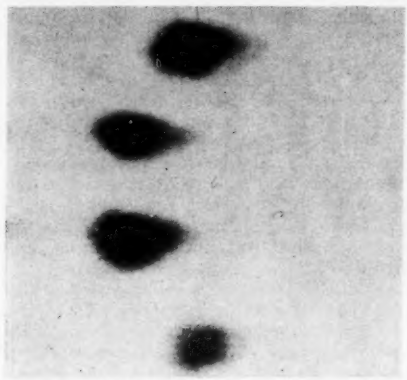

Fig. 1. Comparison of the electrophoretic mobilities of the new embryonic and adult hæmoglobins
a and *d*, normal adult hæmoglobins; *b* and *c*, embryonic hæmoglobin from a ten week old embryo (duplicate run)

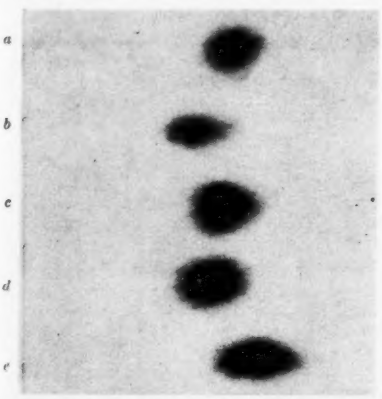

Fig. 2. Comparison of the electrophoretic mobilities of the new embryonic, new-born cordal blood and adult hæmoglobins
a and *e*, normal adult hæmoglobins; *b*, embryonic hæmoglobin from a 20-weeks old fœtus; *c*, hæmoglobin from the cordal blood of a full-term newly born; *d*, mixture of the embryonic and the newly born's cordal blood hæmoglobins

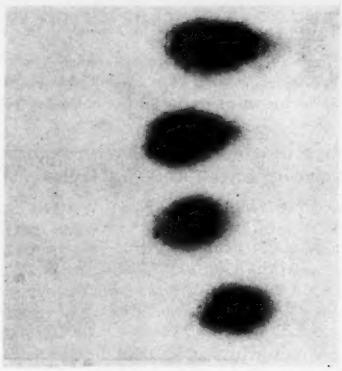

Fig. 3. Comparison of the electrophoretic mobilities of the new embryonic hæmoglobin with those of hæmoglobins from thalassæmic and normal adult blood
a, hæmoglobin from the blood of a nine-months old child with thalassæmia and 32 per cent of alkali-resistant hæmoglobin fraction; *b* and *c*, embryonic hæmoglobins from the ten- and twenty-week-old embryos, respectively; *d*, normal adult hæmoglobin

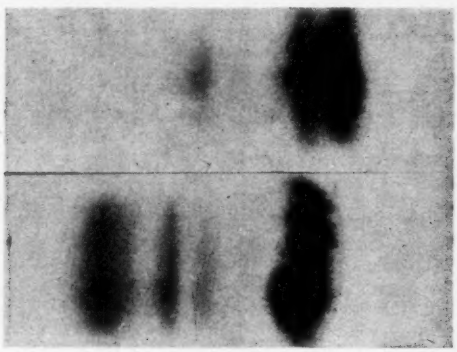

Fig. 4. Electrophoretic pattern of the serum protein of a ten-week-old embryo as compared with that of a normal adult serum (below)

An unusual electrophoretic pattern was found in the serum of the 10-week old embryo, with a total protein content of 2·8 gm. per cent (Fig. 4). In this serum five protein fractions were found, a small one corresponding to α_1 globulin and two others to α_2 and β globulin fractions of a normal adult blood serum, used as control in the same run. Of the two remaining protein fractions with electrophoretic mobilities close to that of the albumin fraction of the adult serum, one of them was not superposable on any fraction of the normal adult or of any newborn cordal blood serum. This fraction may be specific for the blood serum of early embryonic life.

No γ globulin fraction could be found in the serum of the ten-week-old embryo, indicating perhaps that the gamma globulin is formed during the embryonic life much later than the other serum protein fractions.

This study was in part supported by a grant from Dr. William Levine, Brooklyn, New York.

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LETTERS TO THE EDITORS

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Effect of the Local Chromosomal Environment upon the Genotype

Critical data bearing on the question of gene-conversion were obtained by analysis of a yeast hybrid heterozygous for nine different genes. Thirty-four tetrads from a single family heterozygous for the genes controlling cadmium-sensitivity vs. resistance (*CD*/*cd*)[1] and fermentation of methyl-α-D-glucopyranoside (*MG*/*mg*) were obtained from a single hybrid in which most of the nine loci segregated regularly. In addition to *CD* and *cd* a third phenotype (cd^M) was characterized by capacity eventually to achieve cadmium-resistance, presumably by mutation—a potential lacking in the *cd* genotype. The three types are indicated by a three-membered ratio $CD : cd^M : cd$ (Table 1).

Tetrad analysis makes it possible to establish a presumptive difference between recombinations produced by gene-conversion and recombinations produced by crossing-over.

Table 1

(*a*)	*CD MG*	*CD MG*	*cd mg*	*cd mg*	24	
(*b*)	*CD MG*	*CD mg*	*cd MG*	*cd mg*	2	(18,177 and 18,181)
(*c*)	*CD MG*	*CD mg*	*cd mg*	*cd mg*	1	(18,285)
(*d*)	$cd^M MG$	$cd^M MG$	*cd mg*	*cd mg*	1	(18,257)
(*e*)	*CD MG*	$cd^M MG$	*cd mg*	*cd mg*	1	(18,289)
(*f*)	*CD MG*	$cd^M MG$	$cd^M mg$	*cd mg*	1	(18,341)
(*g*)	*CD MG*	*cd MG*	$cd^M mg$	*CD mg*	1	(18,253)
(*h*)	*CD MG*	*cd MG*	$cd^M mg$	$cd^M mg$	1	(18,281)
(*i*)	$cd^M MG$	*CD mg*	$cd^M mg$	*cd mg*	1	(18,297)
(*j*)	$cd^M MG$	$cd^M mg$	*cd mg*	*cd mg*	1	(18,193)

No recombinants between *CD* and *MG* were found in the first twenty-four tetrads. Tetrads (*b*) contained recombinants (underlined) produced by crossing-over. Tetrad (*c*) contained one recombinant (*CD mg*) resulting from gene-conversion (*MG mg mg mg*).

In tetrads (*d*) and (*e*) both *mg* segregants are *cd*, suggesting that the cd^M genes arose by conversion of *CD* to cd^M. In (*f*) one *CD* gene converted to cd^M and one *cd* gene to cd^M. In (*g*) and (*h*) recombinant segregants occur. In (*g*) it appears that a *cd* gene had converted to cd^M and (if this is correct) that a cross-over between *CD* and *MG* had occurred simultaneously. In (*h*) a similar event may have occurred with one *CD* converted to cd^M.

Conversion of *MG* to *mg* occurred in (*i*) and (*j*); in (*i*) conversion of *CD* to cd^M and *cd* to cd^M may have occurred, while in (*j*) conversion of both *CD* genes to cd^M is indicated.

Table 2 shows the genotypes of two parents and the types of segregation in thirty-four hybrid tetrads. In twenty-two tetrads every gene-pair segregated regularly; in five tetrads individual gene pairs segregated irregularly. The remaining seven tetrads showed respectively 2, 2, 2, 3, 3, 3, and 5 irregularities each. The only tetrad irregular for *MA*/*ma* was also irregular for *MG*/*mg*; previous data gave no evidence of dependence[2].

The genes controlling the synthesis of anthranilic acid and histidine are linked[3], and both underwent conversion together in two tetrads, while each was converted once in two other tetrads.

The genes *AN* and *PR* are on different chromosomes, but their conversion is apparently interdependent. The chromosomes carrying these genes segregate in a non-random manner, presumably by synapsis of non-homologous centromeres[4].

In the last tetrad the five gene-pairs undergo conversion concurrently. The *AN* and *PR* genes were converted to the dominant state whereas *MG*, *CD* and *HI* were converted to the recessive state.

Both parents required adenine for growth and neither parent was pink, indicating a further lack of some undefined synthetic capacity. The ability to synthesize methionine is essential for the production of pink pigment in adenine-dependent cultures[5]. Eight asci produced one pink culture; three produced two pinks, while twenty-three produced none. All cultures were tested for their ability to grow in medium lacking adenine. None of the pink cultures could grow in its absence, but thirteen tetrads contained single clones which grew in the absence of adenine after a longer delay than usual for a clone carrying the standard dominant gene. One tetrad contained two such 'slow' clones. Local deficiencies (or excesses) of the materials required for the synthesis of nucleic acids might be expected in cells unable to synthesize adenine. When adequate (or excessive) material is present in a specific position,

Table 2. Types of Segregations of 9 Gene-pairs in 34 Tetrads of One Family

The 2-membered ratios are dominant : recessive; the 3-membered ratios are dominant : intermediate : recessive. The numbers in parenthesis indicate the tetrad serial number. Non-Mendelian ratios are underlined.

12994	*a*	*SU*	*me*	*MA*	*mg*	*cd*	*hi*	*an*	*PR*
17915	*a*	*su*	*ME*	*ma*	*MG*	*CD*	*HI*	*AN*	*pr*

Number of tetrads	Gene pairs								
	a/*a*	*SU*/*su*	*ME*/*me*	*MA*/*ma*	*MG*/*mg*	*CD*/*cd*	*HI*/*hi*	*AN*/*an*	*PR*/*pr*
22	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2
1 (18,261)	2 : 2	2 : 2	3 : 1	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2
1 (18,341)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	1 : 2 : 1	2 : 2	2 : 2	2 : 2
1 (18,257)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	0 : 2 : 2	2 : 2	2 : 2	2 : 2
1 (18,229)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3	2 : 2	2 : 2
1 (18,325)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3
1 (18,289)	2 : 2	2 : 2 : 0	2 : 2	2 : 2	2 : 2	1 : 1 : 2	2 : 2	2 : 2	2 : 2
1 (18,281)	2 : 2	0 : 2 : 2	2 : 2	2 : 2	2 : 2	1 : 2 : 1	2 : 2	2 : 2	3 : 1
1 (18,297)	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3	1 : 2 : 1	2 : 2	2 : 2	2 : 2
1 (18,285)	2 : 2	2 : 2	2 : 2	1 : 3	1 : 3	2 : 2	2 : 2	2 : 2	2 : 2
1 (18,253)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 1 : 1	3 : 1	3 : 1	2 : 2
1 (18,189)	2 : 2	2 : 1 : 1	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	3 : 1	3 : 1
1 (18,193)	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3	0 : 2 : 2	1 : 3	3 : 1	3 : 1

Symbols *a*/*a*, mating-type; *SU*/*su*, sucrose fermentation; *ME*/*me*, melibiose fermentation; *MA*/*ma*, maltose fermentation; *MG*/*mg*, methyl α-D-glucopyranoside fermentation; *CD*/*cd*, cadmium resistance; *HI*/*hi*, histidine synthesis; *AN*/*an*, anthranilic acid synthesis; *PR*/*pr*, proline synthesis.

both dominant genes might be reconstituted and some of the excess used for converting at least one of the defective recessive alleles into a functional dominant, producing a 3 : 1 ratio. When a region suffers a deficiency of constructional materials, it might not always be possible to build a second dominant allele to match the one already present, and a 1 : 3 ratio occurs. Since linked genes (or genes juxtaposed by non-homologous synapsis) behave similarly, it may be inferred that the deficiencies (or excesses) are non-specific. The fact that both excesses and deficiencies of dominants (3 : 1 and 1 : 3) occur in the same cell suggests that nutritional irregularities may be highly localized and that problems of transport are involved.

Emerson's[6] attack on the demonstrability of gene conversion in *Saccharomyces* considers only phenotypic ratios, whereas in the demonstration of gene conversion involving 1 : 3 phenotypic ratios of one gene linked to four others[7], the regular behaviour of the other four genes remains to be explained. His proposal yields contradictory interpretations when applied to a 'conversion' pedigree involving twenty-five families and twelve generations[8]. He does not mention the crucial papers[9] on conversion of the multiple alleles of *MZ* and he cannot explain the present results.

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Sex Chromatin as an Aid to the Identification of Sex in Forensic Medicine

The existence of a sex difference in the morphology of intermitotic nuclei may be of importance, not only anatomically and clinically, but also for its value as an additional method of sex determination in forensic medicine. We have already shown[1,2] that the presence of sex chromatin in the female nucleus can be utilized to determine the sex of unfixed human tissues which have been immersed in water or exposed to atmospheres of varying humidity and temperature. This nuclear feature persists for a period of 2–3 weeks, depending on the nature of the environment in which the tissues decompose.

Further investigations in this Department on the persistence of sex chromatin after death have since been made and emphasize the importance of our previous findings. Portions of full-term human female fœtal tissue were buried in direct contact with the soil, some two feet from the surface. At regular intervals small fragments of skin, muscle and cartilage were removed, prepared by routine histological techniques and the nuclei examined for the presence of sex chromatin. The sex of the tissue could be determined in this way with certainty for four weeks after burial, which was considerably longer than had been the case with tissues degenerating in other environments.

Previously, we compared the persistence of sex chromatin in cartilage cells of fixed and unfixed material and noted that while this mass of chromatin is particularly well seen in fixed cartilage cells from female subjects, in unfixed cartilage its period of survival is no greater than in other tissues. This fact has been confirmed in cartilage cells of young fœtal material by Glenister[3]. We have also found that articular cartilage removed from joints with hitherto intact capsular tissues possesses no advantage in post-mortem sex determination. The cells of the dental pulp in extracted teeth were examined in anticipation that, being virtually sealed from their surroundings, nuclear detail might be preserved for an extended period. However, sex chromatin persists for only 24 hr. in isolated teeth and for a maximum of one week in teeth immersed in physiological saline, the latter being considered to simulate the environment of teeth *in situ* after death. We conclude, therefore, that sex chromatin persists for a similar length of time in the majority of tissues.

A method has been described for the determination of sex from blood films[4]. We have attempted to determine sex in this way from an examination of blood on scalpel blades used in the dissection of fresh post-mortem tissues, but find it of no value, due to hæmolysis with complete destruction of white blood cells. However it is often possible to determine sex from accompanying epithelial cells transferred from the skin, even on blades afterwards kept in room air for a number of weeks. A preliminary investigation into the possibility of sexing human hairs in a similar way, from epithelial cells adhering to the roots of hairs removed from the scalp, indicates that, as with material adhering to instruments, diagnosis can be made.

Reference to the most recent text-books of forensic medicine reveals that the original work on sex chromatin by Murray Barr and his colleagues only receives mention by Polson[5], and no suggestion has yet been made as to the possible medico-legal significance of this aspect of cell morphology. The results of our investigations, which will be published more fully, show that the sex of small fragments of mutilated tissue, of material adhering to instruments and of human hair can be determined, in certain circumstances, from the appearance of nuclear chromatin.

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The Fine Structure of Bone

X-Ray crystallographic studies by Engström and his collaborators[1,2] have shown that the apatite crystallites of bone have linear dimensions of about 220 A. × 65 A. The crystals were aligned with their long axis parallel to the collagen fibre axis, and it was suggested that there may be three such inorganic crystals for each 640 A. period of the collagen fibril. In a recent communication, Fernández-Morán and Engström[3] observed a "predominance of rod- or needle-shaped apatite particles 30–40 A. wide and about 200 A. long" in thin sections of bone by means of electron microscopy. This result is in reasonable agreement with those obtained by X-ray diffraction; but no evidence is offered that the regions of higher density present in the micrographs (which appear to have reproduced badly) were in fact due to apatite. Nor is it clear whether electron microscopy has provided any further evidence as to the manner of alignment of the particles, for Robinson and Watson[4] have identified apatite in thin sections of bone by means of electron diffraction, and have indicated that the particles were deposited on the 'doublet' band region of the period of the fibril.

Electron microscopy and X-ray diffraction, however, have not given unequivocal results regarding the site of the apatite particles; but work in this Laboratory has clarified the position to some extent[5]. In this work transverse and longitudinal sections of undecalcified embryonic avian bone were cut with a glass knife, and viewed in a modified Metropolitan-Vickers (*E.M.*III) electron microscope. Densitometer traces of electron micrographs of newly formed osteogenic fibrils demonstrated at least five bands and five interbands within a main period of the collagen fibril. At an early stage of calcification, very dense particles, of less than 100 A. in size, became localized in a ring between the *d* and *ab* bands of the main period, that is, in the major region of indentation of the period (Fig. 1). In transverse sections of the appropriate part of the fibrils, the particles were seen to be irregular in outline, were about 100 A. apart, and numbered up to ten per ring.

Measurements of the Bragg spacings of powder diffraction patterns, obtained by electron diffraction of such sections, were in close agreement with those obtained from a control specimen of hydroxyapatite. It is therefore considered that these particles are to be identified with the apatite component of bone. There was no clear evidence, however, from either electron microscopy or electron diffraction, of any preferred orientation of the particles with respect to the fibre axis. The observation on embryonic bone of the localization of dense apatite particles between the *d* and *ab* bands is precise, and it is believed that such clarity of deposition has not been recorded in previous work. This finding may also have a bearing on the mechanism by means of which the apatite crystals become preferentially orientated with their c-axis parallel to the collagen fibre axis already demonstrated by means of X-ray diffraction[1].

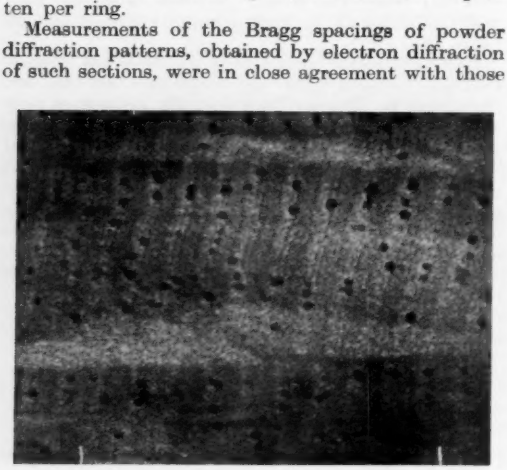

Fig. 1. A section of periosteal bone from a 16-day embryo, showing the periodic structure of the collagen fibrils; apatite particles are localized in one interband of each period, namely, between the *d* and *ab* bands. × 110,000

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The Lateral Rectus Muscle and Sixth Cranial Nerve in the Pig

The lateral rectus muscle and sixth nerve have been studied in four young pigs ranging in age from three to six weeks. Fixation of the orbital contents and brain stem was ensured by ante-mortem perfusions. The muscle was examined in frozen sections taken through longitudinal and transverse planes, and stained by the diammine silver ion technique[1]. A block of the brain stem extending from the upper medulla to mid-brain was treated by the Bielschowsky pyridine–silver process, and sections, namely, dorso-ventral, longitudinal and transverse, were examined. The trunk of the sixth nerve was studied in preparations stained by hæmatoxylin and eosin and by methylene blue.

The volume of nerve in the lateral rectus was calculated to be approximately 9 per cent. Four main types of ending were observed in the muscle: (1) motor end-plates, found most abundantly in the posterior and middle thirds; (2) muscle spindles of standard type, anteriorly placed and deep to the peripheral zone of small muscle fibres; (3) large numbers of longitudinal fibres connected by collaterals and ending freely in fine filaments on the muscle fibres; (4) tendon endings at the attachments of the muscle.

Nerve cells on the sixth nerve in man have been reported by Nicholson[2]. In two of our animals, a few small ganglia were observed adjacent to the fibres of the sixth nerve in the region of the cavernous sinus.

Each ganglion consisted of 8–12 small multipolar cells intermingled with groups of non-myelinated nerve fibres. These structures, being morphologically similar to autonomic ganglia, were regarded as fragments from the plexus on the wall of the internal carotid artery.

A small-celled component near the rostral limit of the abducens nucleus was studied with particular care. The cells here are not representative of first-order neurones, and their function is not known.

In the cat[3] and the pig[4,5] a contribution has been reported from the mesencephalic root of the fifth nerve to the trochlear nerve at its decussation. In the case of the sixth nerve, no similar direct connexion was evident. Investigations are now being carried out concerning a possible connexion between the first division of the trigeminal and the oculomotor nerves in the pig; such a connexion has been observed in man and certain mammals by other workers.

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Milk Production and Interval between Milking

In a recent communication[1] results were presented challenging the generally accepted theory that secretion-rate in the dairy cow declines with time in the interval between successive milkings. These Ruakura experiments showed that secretion-rate was constant up to 20–24 hr. It was suggested that, under a twice-a-day milking regime, unequal intervals of considerable magnitude might be employed without any significant difference in milk yield due to direct pressure effects.

An experiment to test this has recently been completed at Ruakura. The work extended over two years. In the first year seven sets of monozygotic twins and in the second year eleven sets were milked such that one member of each pair was milked at equal 12-hr. intervals and the other member at intervals of 8 and 16 hr.

Mean productions for the complete lactations were:

	Year	No. of sets	Milk	Fat	Days
12—12	1954–55	7	5628·3	252·4	232
16—8			5461·4	246·1	232
12—12	1955–56	11	6438	316	264
16—8			6555	321	264

These results are not only of obvious theoretical interest but also have important implications for the dairy industry.

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Preferential Uptake of Sulphone by Affected Skin Tissue of Leprosy Patients as detected by a Tracer Method

Diamino-diphenyl-sulphone and a number of its derivatives have been found to be very effective in the treatment of leprosy; but the exact mode of their action on the affected tissue and invading *Mycobacterium* has not yet been definitely established[1–3]. In the present work, diamino-diphenyl-sulphone labelled with sulphur-35 was used for studying the time variation of concentration of the drug in blood and healthy and diseased skin tissues of the leprosy patients. An interesting observation was that the drug was found to be localized to a greater extent in the affected tissues compared to healthy ones. Such studies were not possible with the help of earlier colorimetric techniques[4], as these required tissues in bulk. The method used here was found to be ten times more sensitive than the colorimetric techniques.

Diamino-diphenyl-sulphone labelled with sulphur-35 (procured from the Atomic Energy Research Establishment, England) was administered to nine patients as a single oral dose of 4 μc./kgm. body-weight. The specific activity of the drug was about 0·75 μc./mgm. After administration of diamino-diphenyl-sulphone, samples of skin tissues were removed by biopsy from affected sites as well as from adjacent healthy sites, at different intervals. These were finely minced and homogenized with distilled water. The suspension was then uniformly spread over previously weighed copper planchets and dried under an infra-red lamp. Simultaneously with skin samples, blood was also collected from each patient. 0·1 c.c. of blood was similarly dried on the pre-weighed copper planchets. The planchets were reweighed to get the thickness of the sample in mgm./cm.^{2}. The thickness of the deposits varied from 4–6 mgm./cm.^{2}. They were placed under a previously calibrated end-window Geiger–Müller counter (window thickness 2·8 mgm./cm.^{2}) and the activity of the sample was deduced from the recorded number of counts per minute and the sample thickness[5].

The concentration of diamino-diphenyl-sulphone (sulphur-35) in the blood, healthy and affected skin tissues of the leprosy patient is shown in Table 1. It is apparent from the table that the concentration in the healthy skin runs almost parallel to the concentration in blood. Within an initial period of 6 hr. after administration, concentration in blood seems to be 2–3 times that in the healthy skin. If, however, a comparison be made of the concentration of the

Table 1. Variation of the Concentration of Diamino-Diphenyl-Sulphone in Blood, Healthy and Affected Tissues

Patient	Hours after administration	Concentration of diamino-diphenyl-sulphone (in μc./gm.) in Blood	Healthy skin	Affected skin
Nature of lesion: single				
M. H.	6 hr.	0·035±0·002	0·013±0·003	0·143±0·007
P. M.	18 ,,	0·019±0·002	0·014±0·003	0·140±0·006
G. H.	24 ,,	0·008±0·003	0·009±0·003	0·084±0·006
M. S.	144 ,,	0±0·001	0±0·001	0·010±0·003
Nature of lesion: multiple				
B. M.	6 hr.	0·036±0·002	0·016±0·003	0·067±0·005
M. Y.	18 ,,	0·008±0·003	0·005±0·002	0·064±0·005
B. D.	24 ,,	0·010±0·003	0·005±0·002	0·083±0·006
J. S.	72 ,,	0±0·001	0±0·001	0·004±0·001
M. R.	144 ,,	0±0·001	0±0·001	0·005±0·002

N.B. The errors indicated in this table are the standard errors of beta-counting only.

drug in the diseased skin with that in the healthy, the relative concentration of sulphone is about ten times greater in the diseased site. No significant difference could be observed in the concentration of diamino-diphenyl-sulphone in the case of multiple lesions compared with those with single lesions. 72 hr. after the administration of the drug, the concentration in the blood or healthy skin was too feeble to be detected by our method.

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Effect of Antibiotics on the Growth and Alkaloid Production of Tobacco Plants

Antibiotics are being used increasingly for the chemotherapy of plant diseases. In tobacco it has been proved effective to use streptomycin to control blue mould[1] and wildfire[2]. In *Datura stramonium*, Steinegger[3] showed that penicillin increased both the growth and alkaloid production. Nickell[4] stated that a change in the alkaloid content of tobacco plants by using antibiotics could be utilized to good advantage.

Several tests were made with Robinson Medium Broadleaf Maryland tobacco, using bacitracin, sodium penicillin, streptomycin sulphate, dihydrostreptomycin sulphate, terramycin hydrochloride and agrimycin 200 *C* (streptomycin 660 μgm./mgm.) supplied by Chas. Pfizer and Co. (The constant interest and help of Dr. R. A. Benedict, Mr. V. J. Carroll and Dr. L. G. Nickell, of Chas. Pfizer and Co., are acknowledged.)

Greenhouse solution cultures containing four concentrations of agrimycin 200 *C*. Agrimycin 200 *C* was added to the nutrient solution[5] at concentrations of 0, 10, 50, 100 and 200 p.p.m. of streptomycin. The fresh weights of the entire plants produced after two months in 2-litre crocks of this solution were 287, 336, 194, 110 and 59 gm., respectively. The percentages of total alkaloid on fresh-weight basis were 0·025, 0·024, 0·039, 0·047 and 0·019, respectively. The amounts of alkaloid per plant were 70·5, 80·3, 75·9, 51·7 and 11·1 mgm., respectively. Thus a small concentration of streptomycin appears to have been slightly beneficial; but larger concentrations were definitely unfavourable, causing more pronounced stunting and browning of the roots than of the tops; but at the highest concentration dead spots appeared on the leaves. Since growth was inhibited to a greater degree than alkaloid synthesis, a maximum alkaloid percentage, on a weight basis, was produced at 50–100 p.p.m. However, no evidence of specific increase in alkaloid synthesis was observed.

Greenhouse solution culture containing other antibiotics. The experimental conditions were similar to the preceding one except that larger nutrient solution containers were used. Since the structure of bacitracin is incompletely known, it was used at 5 and 20 units per litre. The other antibiotics were tested at concentrations of 50 and 200 p.p.m. The fresh weights of all other plants were less than the control (780 gm.), except the lower concentration of penicillin (782 gm.). In all cases the plants grown at the higher concentration of the antibiotic were smaller than at the lower. In the cases of the lower concentration of streptomycin sulphate, dihydrostreptomycin sulphate and sodium penicillin the quantity of alkaloid synthesized per plant was 317·1 mgm., 275·7 mgm. and 216·5 mgm., respectively, and was greater than the control (190·9 mgm.), tending to confirm the indications obtained at the lowest concentrations in the first experiment. Thus there may be an optimum concentration of each antibiotic in the nutrient solution at which the fresh weight and alkaloid synthesis are maximum; but if such optimum exists it is very low. This may be due to the influence of the antibiotic in depressing competitive development of micro-organisms in the nutrient solution. However, at higher concentrations all the antibiotics had an unfavourable effect on alkaloid synthesis as well as on fresh weight.

On examination of the antibiotic activity in the root, stem and leaves of these plants it was found that all parts of the plants which had received streptomycin and dihydrostreptomycin showed significant antimicrobial activity compared to the control. In the terramycin samples only the root gave significant activity, and significant activity was not found in any part of the bacitracin or penicillin samples.

Antibiotic sprays on the tops of plants grown in soil. The five antibiotics as used in the previous experiment were tested in this experiment, also. Bacitracin was used at 200 units per litre and the other four at 200 p.p.m. Tobacco plants were grown in 7-in. pots in the greenhouse. They were divided into three groups and each was sprayed with a given antibiotic twice, four times, or six times at intervals of 30, 15 or 10 days, respectively, during their growth period. No significant differences were found either in plant size or in alkaloid content per plant due to the antibiotic used or the frequency of spraying.

Field test on spraying with different concentrations of penicillin. Since penicillin showed an increase of both plant growth and alkaloid production of *Datura stramonium*[5] and also indicated how little it affected plant size in the solution culture, it was tried in the field by spraying ten times at intervals of 10 days throughout the growth period with several concentrations of penicillin; namely, 0, 50, 100 and 200 p.p.m. These four treatments, in four replications, were laid out in the field in a Latin square design. Statistical analysis of the results did not show any significant difference either in fresh weight of plant, in alkaloid concentration, or in total alkaloid produced per plant due to different treatments.

The experiments described above failed to show any effects on the plants produced by antibiotics sprayed on the leaves. They did demonstrate marked unfavourable effects of any considerable concentration of antibiotics in the nutrient solution. They showed some evidence of stimulatory effects of small concentrations in the nutrient solutions;

but these may be secondary effects. It appears improbable that such small concentrations could be provided reproducibly to the roots of plants growing in soil. Thus, commercially grown tobacco leaf of 'predesigned' alkaloid content does not appear to be feasible by any of the antibiotic applications described in this paper.

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A Chemotactic Response in Wheat Bulb Fly Larvæ

The eggs of wheat bulb fly (*Leptohylemyia coarctata* Fall.) are laid in the soil during the summer and are usually found on fallow land or where there is a light cover of vegetation such as potatoes. The larvæ develop and remain in the egg in diapause until the following January or February. Meanwhile, such fields may have been autumn-sown with wheat which the larvæ infest upon hatching[1]. The mechanism by which the larvæ locate the wheat plants is the subject of this investigation.

Laboratory observations indicated that cut wheat shoots could be detected in Petri dishes by the larvæ when both larvæ and shoot were on damp filter paper; but when the shoots were separated from the damp paper by a cover glass laid under them the results were less positive. The use of growing plants was more desirable in tests and the following method was evolved. Wheat seeds were germinated on damp filter paper in Petri dishes and transplanted into a sodium alginate jelly when the first leaf emerged from the coleoptile. Identical dishes of jelly without wheat were made up simultaneously. In preliminary tests, cubes of jelly taken three or four days later from the wheat dish without including or damaging the roots or plants and similar cubes from the non-wheat jelly were placed on damp filter paper around the edge of a Petri dish, and newly hatched, unfed wheat bulb fly larvæ were introduced centrally. A large number of larvæ was later seen in the wheat jelly cubes.

To test this observation, ten Petri dishes were then arranged. The dishes were set up as follows, after minor adjustments in the first five: the jelly was made up to the formula of 1 gm. sodium alginate 'Manucol' *SS/LM* and 0·2 gm. calcium citrate to 100 ml. of water. In each dish one ¼-in. cube of wheat jelly and a similar one of non-wheat jelly were placed opposite and equidistant, ¼ in. away from the central ¼-in. square in which ten newly hatched larvæ were introduced. The dishes were orientated differently. The lids were marked out in ¼-in. squares and the positions of the larvæ which immediately began to move were recorded on correspondingly squared graph paper every ten minutes.

The larvæ began to aggregate quickly in the wheat jelly, the total number in the various sites after approximately 1 hr. being shown in Table 1.

Table 1. Larvæ found in Various Sites in Petri Dishes containing Cubes of Wheat and Non-wheat Jelly

Test	No. in wheat jelly	No. in non-wheat jelly	No. still wandering	Missing
1	7	2	1	0
2	1	0	9	0
3	6	1	3	0
4	4	1	5	0
5	1	1	8	0
6	5	0	5	0
7	4	1	4	1
8	7	0	3	0
9	5	0	5	0
10	4	1	5	0
Totals	44	7	48	1

The total area on which the larvæ could wander (including the sides and top of the cubes) per dish was 12·1 sq. in. The area of 1 cube (minus base) was 1·25 sq. in. while the proportion of the total area occupied by one cube was 0·104. The number of larvæ which could be expected in an area of cube size per dish would be $1{\cdot}04 \pm 0{\cdot}43$ should the wandering be of a random nature; but this is considerably exceeded by the larvæ in the wheat jelly. It is probable that an exudation from the wheat plants into the jelly and thence into the damp filter paper was detected by the larvæ.

The nature of the larval response is still being investigated, as is the constitution of the substance in the wheat jelly. The speed with which a substantial proportion of the larvæ find the jelly (in some experiments 60 per cent reached it within ten minutes) suggests that the response is a directional one (taxis); but the nature and speed of the movement may also be influenced (kinesis)[2]. The larvæ are able to leave the jelly after entering it and when exposed for 24 hr. they become dispersed over the dish. It is possible that by this time the substance in the wheat jelly has diffused more or less evenly throughout the dish.

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Inhibitory Effect of Glucose on Enzyme Formation

The induced biosynthesis of many microbial enzymes is susceptible to the inhibitory effect of glucose[1]. The physiological significance of this phenomenon has been indicated by the study of an L-histidine-requiring mutant strain of *Aerobacter aerogenes* in which glucose inhibits the formation of histidase, thereby conserving the L-histidine for its specific role as growth factor[2]. Under conditions that permit a gratuitous, linear production of *myo*-inositol dehydrogenase (another inducible enzyme in *A. aerogenes*) in the absence of the inducing agent, the glucose effect is still operative, indicating that glucose interferes with the production of enzyme rather than with the process of induction[2].

Recently, it has been possible to demonstrate in two instances the reversal of the glucose inhibition of induced enzyme biosynthesis. In a wild strain of *A. aerogenes* L-histidine was substituted for ammonium sulphate, the customary nitrogen source of the glucose-containing minimal medium. In a mutant

Table 1. The Production of Histidase and Urocanase by Two Strains of *A. aerogenes*

Strain	Growth Medium*				Histidase† (units/10 mgm. cells)	Urocanase† (units/10 mgm. cells)
	L-Histidine	Glucose	$(NH_4)_2SO_4$	L-Glutamate		
Wild	+	−	+	−	170	403
	+	−	−	−	182	420
	+	+	+	−	< 5	< 5
	+	+	−	−	70	220
L-Glutamate-requiring mutant	+	−	+	+	203	398
	+	−	+	−	197	366
	+	+	+	+	< 5	< 5
	+	+	+	−	65	130

* These substances were added, where indicated, to the basal salt medium in sufficient amounts to give a final concentration of 0·2 per cent.
† Histidase and urocanase are the first two enzymes in the series degrading L-histidine to L-glutamic acid, formamide and ammonia (ref. 4). They were assayed by determining the ability of dried-cell preparations to degrade L-histidine and urocanic acid, respectively (ref. 3). One unit of enzyme is defined as that activity which results in the degradation of 0·1 micromole of substrate in 1 hr. under the conditions of the assay.

strain of this organism (kindly supplied by Dr. B. D. Davis, of New York University) which required L-glutamic acid for growth, L-histidine was substituted for L-glutamic acid in a glucose–ammonium sulphate medium. In both cases the production of histidase in the presence of glucose was a prerequisite for growth, and both conditions resulted in growth of the cells and the formation of the histidase series of enzymes (Table 1).

These observations demonstrate that glucose permits histidase biosynthesis in *A. aerogenes* when the action of this enzyme system furnishes products necessary for growth and not obtainable from the degradation of glucose. Conversely, glucose inhibits histidase biosynthesis when the products of the reactions catalysed by this enzyme system merely augment the supply of metabolites resulting from glucose degradation.

Compared with that of other substances, the degradation of glucose by *A. aerogenes* has one unusual feature. Glucose is metabolized under aerobic conditions at a rate which is at least double that commensurate with the growth-rate and total crop of cells; the extremely large amount of glucose metabolized during growth is reflected in the amount of labile ('high energy') phosphate present in the cells (Table 2). Additional information obtained in this laboratory indicates that the metabolism of glucose in the presence of inorganic nitrogen (NH_4^+) results in a plentiful supply of nitrogenous organic compounds. These results are in good agreement with the observation that vitamin, amino-acid and purine and pyrimidine supplementation fails to increase the growth-rate of this organism on glucose, while such supplementation does accelerate growth on other substances[3]. Cells growing on glucose, far from being deficient in the substances necessary for protein synthesis, actually possess these substances in excess. The uniformly negative results of past attempts to effect a reversal of the glucose inhibition by enriching the growth medium are thus understandable.

Table 2. Some Characteristics of the Growth of *A. aerogenes* on Different Substances

Substrate	Carbon uptake in μatoms/ mgm. growth	Labile PO_4 in μmo'es/ mgm. cells*	(k)†	Rate of carbon uptake‡ μatoms/mgm./ hr.
Glucose	110	12·2	1·26	139
L-Histidine	89§	7·7	0·59	53
Glycerol	58	2·1	1·00	58

* These experiments were done in collaboration with Mr. Fred Valentine.
† The growth-rate constant, k, is defined by the expression, $dC/dt = kC$, in which C is the turbidity of the culture in optical density units, and t is time expressed in hours.
‡ This was calculated by multiplying the carbon uptake (μatoms/ mgm. growth) by the growth-rate constant ($hr.^{-1}$) of the cells on that particular substance.
§ L-Histidine is assumed to have five utilizable carbons. One of its carbon atoms is not metabolized, but excreted as formamide.

If we now consider the class of enzymes the formation of which is inhibited by glucose metabolism, an interesting generalization can be made: the 'glucose-sensitive' enzymes the biological functions of which are known furnish the cell with carbon-building blocks and energy (for example, enzymes degrading carbohydrates) or nitrogen (for example, amino-acid deaminases), that is, products also readily obtainable from the metabolism of glucose.

This generalization permits a clearer conception of the inhibition. It would appear that the levels of the metabolites resulting from intermediary metabolism control the synthesis of enzymes which form these metabolites, presumably by a system of feedback mechanisms. The existence of analogous feedback mechanisms controlling biosynthetic reactions has already been indicated[5], and in some cases it can be shown that the actual formation of a biosynthetic enzyme is inhibited by the presence of the final product of the reaction sequence[6]. Thus, certain biosynthetic enzymes, too, seem to be formed only when their products supplement the composition of the growth medium, not when they augment it. Glucose is metabolized so rapidly by an enzyme system always present in the cells that its intermediary products (carbon, nitrogen and energy in forms available for synthetic purposes) are formed faster than they can be removed by anabolic reactions. This accumulation seems to prevent the synthesis of enzymes the products of which would only augment the already large metabolic pools.

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A New Embedding Medium for Electron Microscopy

THE introduction of *n*-butyl and methyl methacrylates as embedding media[1] constituted an important development in the preparation of ultra-thin sections of biological material; but their use is attended by various major difficulties. Shrinkage occurs on polymerization, hard objects are not penetrated by the monomer so that the plastic shrinks away and does not provide sufficient support, and sometimes there is an unaccountable appearance of bubbles around the specimen. Moreover, the polymerization process is not uniform and sometimes causes severe damage. This is perhaps most strikingly seen in bacteria where often only empty remnants of cell walls remain.

Attempts have been made to minimize these distorting effects by modifying the methacrylate procedure[2], but only with partial success. The substitution of a different embedding medium seems desirable. The possible usefulness of the epoxy resins for the preparation of ultra-thin sections of bacteria has already been indicated[3].

We have examined a series of epoxy resins, supplied under the name of 'Araldite'*, for their suitability as embedding media. On the addition of a hardener, which is a liquid anhydride, the resin sets slowly without shrinkage to form a light-gold block. The viscosity of the mixture and the hardness of the final block can be controlled with a plasticizer, dibutyl phthalate, and the rate of hardening can be varied with an amine accelerator. By a suitable variation of these components it is possible to produce an embedding medium with the properties required for electron microscopy. Slightly different combinations will be found convenient for different types of specimen; one such combination is described here.

The components were measured into a graduated cylinder warmed to 48° C. to facilitate drainage and were mixed in the following order:

'Araldite' *M*	100 ml.
Hardener 964 *B*	100 ml.
Plasticizer	10 ml.
Accelerator 964 *C*	3 ml.

Although the mixture can be stored at 4° C. for several days we found it convenient to prepare it in quantities one-tenth of those indicated. After stirring, a clear, golden liquid resulted which was more viscous than methacrylate monomers; but the viscosity could be reduced by holding the solution at 48° C. and infiltrating the specimens at this temperature.

In the preliminary trials the 'Araldite' mixture has been used for embedding bacteria, fragments of lung and mature hair fibres. After fixation and dehydration the specimens were soaked for 1–2 hr. in a 50/50 mixture of alcohol and 'Araldite'. They were then transferred to pure 'Araldite' for 2–3 hr. at 48° C., and finally placed in No. 00 gelatin capsules with fresh 'Araldite'. Curing for 48 hr. yielded a light-gold block with a hardness comparable with methacrylate.

The 'Araldite' had excellent cutting characteristics; sections were floated on to 20 per cent acetone–water, mounted on carbon films and examined in the electron microscope. Their electron density was similar to methacrylate. As had been hoped, bacteria were intact, and hair fibres were sufficiently well supported to allow thin sections to be cut and details of internal structure to be revealed.

It is considered that such an alternative embedding medium will be valuable for studies of tissue fine structure; but the resin must be tested on many different types of specimen before its potentialities can be fully assessed.

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Re-appraisal of the Evidence for the Metabolic Conversion of Vasopressin into a Less Active Derivative

THE intermediary metabolism of peptide hormones is unknown, and it is therefore of great interest that Dicker and Greenbaum[1] have recently suggested "that both kidney and liver slices transform vasopressin into substances of lower antidiuretic activity". They reached this conclusion because they found that the activity of 'Pitressin', when incubated with rat kidney slices, decreased until 20 per cent of the initial antidiuretic potency remained; thereafter, there was no further inactivation. When the resultant supernatant from such an incubation mixture was added to fresh kidney slices its activity remained constant although it could be completely abolished by liver slices. Thus, the property by which Dicker and Greenbaum distinguish between vasopressin and the product of its metabolism is that the latter resists inactivation by kidney slices while vasopressin does not.

The results of *in vitro* experiments do not necessarily apply to the fate of vasopressin *in vivo*, but Dicker and Greenbaum attempted to show that, following intravenous infusion of vasopressin into rats anæsthetized with ethanol, the metabolic derivative of vasopressin is excreted in urine. After infusing large amounts of vasopressin they found that the antidiuretic activity excreted in urine was within the range found in previous investigations (3·1–22·0 per cent of the dose infused[2]). However, when urine containing this excreted activity was infused into another rat, they claim that 48–59 per cent of the dose now appeared in the urine. The explanation offered is that liver and kidneys *in vivo* treat vasopressin and the antidiuretic activity in urine as do slices of these organs.

Table 1. Excretion of Antidiuretic Activity in Urine

Per cent of dose recovered from urine	
'Pitressin' infusion (200–400 mU./rat)	Infusion of urine secreted during and following 'Pitressin' infusion*
4·8	13·8
20·0†	10·4†
5·1†	6·0†
5·4	11·0
Mean 8·8 ± 3·7 (S.E.)	10·3 ± 1·6 (S.E.)

* The urine was adjusted to plasma osmoticity.
† Results obtained in rats anæsthetized with ethanol.

Accordingly, half the infused urinary antidiuretic substance would be destroyed in the liver while the remainder would pass through the kidneys unchanged.

We have been engaged in the study of the fate of vasopressin for some years[2–6], and in continuing this work it was necessary to follow up Dicker and Greenbaum's interesting hypothesis. We have therefore repeated their *in vivo* experiments. We found that in rats infused with 'Pitressin' the urine secreted during the period of infusion (1 hr.) and during the subsequent hour had antidiuretic activity equivalent to between 4·8 and 20·0 per cent of the dose. In rats into which this urinary antidiuretic activity was infused, the urine contained between 6·0 and 13·8 per cent of the antidiuretic activity infused (Table 1). That is, the urinary antidiuretic activity was excreted in the same proportion as was 'Pitressin'. These experiments were performed on both conscious rats and on rats anæsthetized with ethanol.

The transformation of vasopressin *in vivo* into a less-active metabolic product remains a possibility; but the experimental evidence upon which this hypothesis was based cannot be confirmed.

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Protective Action of Vitamin B_{12} in the Hyperthyroid Rat

The protection afforded by vitamin B_{12} against thyrotoxicosis in the rat was explained as due to a restoration in part of the uncoupling of oxidative phosphorylation caused by thyroxine[1]. Since it is known that osmotic damage to mitochondria could cause a diminution in oxidative phosphorylation[2], the possibility was considered that in hyperthyroidism there may be an altered distribution of vitamin B_{12} in the cell fractions.

The basal diet employed was a purified casein ration[3] with vitamin additions including folic acid (3 mgm./kgm. of diet). Groups of six to eight male rats (Wistar strain), 50 gm. in weight, were fed this vitamin B_{12}-free ration with modifications as shown in Table 1. Iodinated casein ('Protomone': Cerophyl Laboratories, Kansas City, Mo.) was added to the diet at 0·3 per cent level. Vitamin B_{12} was given intraperitoneally at 10 gamma/rat on alternate days. All animals were killed at the end of five weeks when those of group 3 showed distinct symptoms of hyperthyroidism. Blood was withdrawn by venipuncture after phenobarbitone anæsthesia, immediately citrated and an aliquot centrifuged for plasma. Livers were excised, chilled in cracked ice and a 20 per cent homogenate prepared in ice-cold isotonic (0·25 *M*) sucrose; an aliquot was used for centrifugal fractionation[4], particulate fractions being carefully washed with sucrose solution.

Vitamin B_{12} in all samples was liberated by overnight incubation under toluene with papain (B.D.H.) using 25 mgm./gm. of liver or per c.c. of blood or plasma, in acetate buffer of *p*H 4·6[5]. The samples were then autoclaved, homogenized, neutralized and made to volume. Assays were made with *Lactobacillus leichmannii* (ATCC 7830) by a turbidimetric adaptation of the U.S.P. method[5]. All results are averages for at least four animals in each of the groups.

It may be seen (Table 1) that in the hyperthyroid rat there is a marked fall in the concentration of vitamin B_{12} in the circulating blood and in the percentage retained in the blood cells; this is prevented by vitamin B_{12} administration. A similar fall in liver and mitochondrial vitamin B_{12} of thyrotoxic animals is also corrected by feeding the vitamin. However, in the latter case, there is a rapid uptake of the vitamin which resides largely in the nuclear and supernatant fractions. It has been observed that the values for vitamin B_{12} in these two fractions return to normal levels when iodinated casein is withdrawn from the diet.

The pronounced lowering of liver and its mitochondrial vitamin B_{12} in hyperthyroidism parallels the known decrease of liver pyridinonucleotides and of their percentage linked to mitochondria[6]. It is also consistent with other observations (unpublished data) on the more rapid *in vitro* release into the surrounding medium of the intramitochondrial nucleotide components[7] from livers of thyrotoxic rats. Since the synthesis of adenosine triphosphate is rendered inoperative as a result of structural damage to mitochondria[2], the observations on the protective action of vitamin B_{12} against thyrotoxicosis[1] seem explicable on the basis that vitamin

Table 1

Group	Vitamin B_{12} in blood		Vitamin B_{12} in liver			
	Whole blood	Plasma	Whole homogenate	Nuclei	Mitochondria	Supernatant
	mμgm./c.c.		mμgm./gm. of liver on wet basis			
1. Basal diet	1·53 ± 0·43*	0·65 ± 0·15*	45·5 ± 5·2*	14·2 ± 1·0*	12·9 ± 0·7*	16·8 ± 2·7*
2. Basal diet + vitamin B_{12}	1·80 ± 0·30	0·81 ± 0·19	49·2 ± 3·7	20·8 ± 1·8	13·2 ± 1·2	12·9 ± 0·9
3. Basal diet + iodinated casein	0·90 ± 0·30	0·55 ± 0·25	37·9 ± 2·5	13·7 ± 0·7	8·1 ± 0·3	14·7 ± 1·3
4. Basal diet + iodinated casein + vitamin B_{12}	2·01 ± 0·25	1·10 ± 0·25	96·3 ± 4·5	41·3 ± 3·0	18·4 ± 0·4	31·9 ± 3·1

* Standard error.

B_{12} aids in the maintenance of mitochondrial integrity.

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Effect of Orotic Acid on Vitamin B_{12}-deficient Rats

Studies in this laboratory[1,2] have recently shown that orotic acid is a factor for growth and survival in rats depleted of the animal protein factor of casein. Also, vitamin B_{12} has a protective effect on the deficiency in animal protein factor[3]. This indicates a relationship, from a nutritional point of view, between vitamin B_{12} and orotic acid. In the present communication the direct influence of orotic acid upon the deficiency of vitamin B_{12} is reported.

To this end, thirty-six weanling rats, male and female in equal number, of the Sprague–Dawley strain weighing 40–45 gm. were employed. The animals were divided into three groups, all of which were fed the basal vitamin B_{12}-deficient corn–soybean meal ration proposed by Register *et al.*[4], namely, whole ground yellow corn 46·35 gm., commercial soybean meal 46·35 gm., corn oil 5 gm., cystine 0·3 gm., calcium hydrogen phosphate 0·92 gm., calcium carbonate 0·6 gm., sodium chloride 0·44 gm., crystalline manganese sulphate 0·04 gm., thiamine 0·3 mgm., riboflavin 0·3 mgm., niacin 2 mgm., pyridoxine 0·2 mgm., pantothenic acid 2 mgm., folic acid 0·025 mgm., biotin 0·01 mgm., inositol 10 mgm., choline 100 mgm., *p*-aminobenzoic acid 25 mgm.; vitamins A and D were administered weekly. Iodinated casein or desiccated thyroid were omitted.

Group 1 served as control and received only the basal ration. Group 2 were fed the basal ration supplemented with vitamin B_{12} (2γ/100 gm. of diet). Group 3 received the basal ration supplemented with orotic acid (1,000γ/100 gm. of diet).

The animals were maintained on their respective ration for 4 weeks; at the end of this period weights were recorded and the liver betaine–homocysteine transmethylase activity was determined, on 6 animals for each group, by the method of Williams *et al.*[5]. It is known, in fact, that in vitamin B_{12}-deficiency growth is retarded, and the liver betaine–homocysteine transmethylase activity is decreased[5].

The results are shown in Table 1.

Table 1

Group No.	Supplement to 100 gm. basal ration	Body-weight after 4 weeks (gm.)	Transmethylase activity, γ methionine formed per hr. per gm. liver
1	None	95 (77–113)*	300 (288–322)*
2	2γ vitamin B_{12}	120 (104–155)	510 (425–580)
3	1,000γ orotic acid†	117 (107–133)	440 (383–517)

* Range of individual values.
† Orotic acid manufactured by Biochemical Inc., Co., Cleveland, Ohio.

From these results it appears that orotic acid has a growth-promoting action on the B_{12}-deficient rats; moreover, orotic acid is a factor stimulating liver betaine–homocysteine transmethylase activity.

These data suggest a metabolic relationship between orotic acid and vitamin B_{12}.

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Glass Surface and Blood Coagulation

Platelet-free, citrated plasma, collected and handled in silicone-treated apparatus, has a very long clotting time on recalcification. The exposure to glass surface greatly shortens the clotting time, and various hypotheses have been advanced to explain this phenomenon[1–4]. The present study is an attempt to examine certain aspects of this reaction by the exposure of various normal and pathological plasma specimens and plasma fractions to a standard glass surface in the form of glass 'ballotini' spheres of 0·12 mm. average diameter. The activity may be assessed either by recalcifying the activated specimen directly or by adding a sample to a standard volume of silicone-collected plasma and recording the recalcified clotting time of the mixture. The use of this silicone plasma as a diluent is essential for testing samples which are devoid of one or more clotting factors (cf. Table 1). (For reasons to be discussed elsewhere, in some experiments 'silicone plasma' containing 2,000–10,000 platelets/c.mm. was used as the diluent for the activated, platelet-free samples.)

The results of such experiments are shown in Table 1, and it will be seen that the ability to respond to glass contact is not lost after heating at 56° C. or after absorption with aluminium hydroxide and is retained in the 30–50 per cent saturated ammonium sulphate fraction. These properties suggest that the substance concerned is not identical with any known plasma-clotting factor. The activation by glass contact could also be demonstrated in hæmophilic and christmas disease plasma and in the plasma of patients treated with dindivan, which indicates that the factors deficient in these samples cannot be directly concerned with contact activation. By adding small samples of glass-contacted plasma or fractions to platelet-rich plasma in siliconed containers, the prothrombin consumption of the latter was found to be markedly increased and thrombin generation greatly accelerated. These findings are consistent with past observations, based on different methods of approach[4–6]. Control samples of the

Table 1

Substance tested	Recalcified clotting times (sec.) in silicone*			
	Glass-activated sample undiluted	Activated sample : dilution in silicone plasma		
		1 : 3	1 : 9	0
1. Normal plasma				
a, untreated	165	245	310	2,000
b, heated at 56° C.†	∞	285	325	2,000
c, adsorbed with $Al(OH)_3$	∞	240	340	3,000
d, heated and adsorbed with $Al(OH)_3$	∞	290	360	1,100‡
2. 30–50 per cent saturated $(NH_4)_2SO_4$ fractions of :				
a, adsorbed plasma	∞	230	305	2,200
b, heated and adsorbed plasma	∞	260	330	3,000
3. Euglobin from 2*b*	∞	320	420	1,320‡
4. Hæmophilic plasma	3,600+	225	260	915‡
5. Christmas disease plasma (mild case)	500	210	380	4,400
6. Dindivan plasma (see text)	355	240	305	1,200‡

0·2 ml. of glass-activated samples or of their mixtures with silicone plasma were recalcified with 0·05 ml. of 0·1 *M* calcium chloride at 37° C.

* The clotting times are strictly comparable only within each individual experiment, that is, horizontally.

† Denatured fibrinogen precipitate was removed by high-speed centrifugation.

‡ Platelets (2,000–10,000/cm.) were deliberately added to the silicone plasma in these experiments.

substances, listed in Table 1, were not exposed to glass contact and had no effects comparable with the contacted specimens, showing that their activity was specific to glass contact and not incidental to the methods of preparation of the plasma fractions. The euglobulin fractions formed an exception to this rule and were apparently activated by the dilution procedure in the course of their preparation.

When plasma which has been exposed to a large glass surface is removed from contact with glass, its clotting time rapidly lengthens, showing that the activity is unstable. This sequence of activation – decay can be repeated ; but the response is lessened with each repetition until the plasma is 'exhausted' and will not clot in glass. On the other hand, heated plasma or the fractions in Table 1 are much more stable in this respect when incubated alone, but will still rapidly lose activity when mixed with untreated plasma. A heat-labile inhibitor system in plasma would account for these findings. If such an inhibitor is related to that described by Fiala[3] it would make it difficult to accept his hypothesis, according to which the shortened clotting time of plasma exposed to glass and other surfaces is due to the absorption of an inhibitor by these substances.

The most plausible explanation of the present findings is that an active substance is liberated from a precursor at the glass-plasma interface and is afterwards rapidly destroyed by an antagonist. The actual level of activity under any given contact conditions would then represent a dynamic equilibrium between these two opposite effects, the precursor being continuously exhausted at a rate which depends on the contact area, temperature, etc. A better understanding of the kinetics of this phenomenon will help to control an important variable in coagulation tests and thus increase their sensitivity and accuracy. For example, platelet-free plasma from dindivan-treated patients has been found to have a consistently prolonged coagulation time when recalcified under standard contact conditions (for example, with glass powder, or as in Table 1). Quantitative aspects and methods of measurement of the reactions described will be discussed in a further communication.

In a wider sense the 'contact' phenomenon may be of physiological significance as an initial stage of a general reaction to 'injury' (cf. the "pain producing substance"[7]) of which blood clotting is only one, rather late, evolutionary offshoot. The final formation of fibrin clot may, nevertheless, provide a very convenient indicator for the study of such early injury reactions the effects of which are by no means limited to coagulation.

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Pharmacological Effects of Certain Diaminodiphenoxy Alkanes

A series of diaminodiphenoxy alkanes was found independently by Raison and Standen[1] and Collins, Davies and Hill[2] to possess high schistosomicidal activity. Hill[2] has described in detail the therapeutic effects of one of these compounds in comparison with lucanthone (Miracil *D*), which is used in the treatment of bilharzia, and found that in mice the compound 1 : 5-di (*p*-aminophenoxy) pentane dihydrochloride (M. and B. 968*A*) was more active than lucanthone. The relative therapeutic indices were 3·3 ($LD50$ = 0·62 mgm./gm., $CD50$ = 0·19 mgm./gm.) and 0·9, respectively, and it had a more rapid action in clearing the mice of the schistosomes.

While the pharmacology of this compound and other active compounds was being studied, we encountered a toxic effect on the eye. This precluded the clinical use of this particular compound, though other compounds which retained therapeutic activity, yet were sufficiently devoid of this toxic action, will be described elsewhere.

On the oral treatment of monkeys, infected with *S. mansoni*, with daily doses of 100 and 200 mgm./kgm. of M. and B. 968*A* for four days, temporary impairment of vision occurred. This was obvious from their abnormal feeding behaviour—they could not readily see or focus on the food presented to them—and a marked dilatation of the pupils, which did not constrict to strong illumination either so readily or to the same extent as a normal eye.

Investigation showed that vision was impaired in some species, but not in others. The mouse, rat, guinea pig, rabbit and ferret were insensitive to single oral doses up to 400 mgm./kgm. (about two-

thirds of the mean lethal dose in the mouse). On the other hand, the monkey, dog and cat were highly susceptible. In the cat, the species chiefly studied, single doses of 100–400 mgm./kgm. by mouth or by subcutaneous injection, or 25–50 mgm./kgm. given intravenously, caused loss of the blink reflex and marked dilatation of the pupils with almost complete loss of the pupillary, light and near reflexes. Visual perception, as judged by the animals' behaviour, was also impaired within twenty-four hours. If the compound was acting centrally, all the optic centres would be affected, but this seemed improbable in the absence of other central nervous symptoms.

The instillation of eserine into an affected eye within a few days of treatment, or peripheral stimulation of the oculomotor nerve in decerebrate preparations, caused pupillary constriction, indicating that paralysis of the nerves and muscles responsible for constricting the pupil had not occurred. The mydriasis was not due to an atropine-like or ganglion-blocking type of action. It was therefore inferred that the compound was probably acting directly on the retina or optic nerve.

Ophthalmoscopical changes were first observed after about seven days and consisted in marked constriction of the retinal vessels with pallor of the optic disk; in two weeks there was some pigmentary disturbance which after eight weeks became the predominant feature, producing a fundus picture resembling retinitis pigmentosa. Though this effect on the eye was by far the most characteristic and important toxic aspect of the compound, it also caused vomiting in cats and dogs, when given orally, but no other serious toxic effects were observed.

The significant histological changes in the eye, described in detail elsewhere[4], were almost entirely confined to the retina, there being widespread injury to the outer layers of the retina with total or patchy destruction of the visual cells, and localized displacement of the outer nuclear layer of the retina with arcade and rosette formation. There was marked degeneration and proliferation of the pigment epithelium. Bipolar cells and ganglion cells were preserved. Histologically these changes most closely simulate those which follow the administration of sodium iodate[5–7], rather than those resulting from iodoacetate[7,8].

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Test for Cross-linking of Linear Polymers

Certain linear polymers which have been used as picture varnishes are known to become cross-linked by the action of light. It is important to us to find out whether this is likely to happen for any particular case, since the insolubility resulting from cross-linkage makes it impossible to remove the varnish by solvent action alone.

The method which has been developed requires only a small rectangle of the varnish film (4–9 mm.^{2}, 20μ thick), and can be completed within an hour. The fragment of film is attached near the bottom of a filter-paper strip with one or two drops of a suitable solvent from a micrometer syringe. The fragment is then leached by developing the strip as in paper chromatography, although in this case there is only one solvent phase, and lengthy equilibration is unnecessary. This solvent should be chosen from among the best for the polymer. A dye, absorbed preferentially by either polymer or paper, may be dissolved in it.

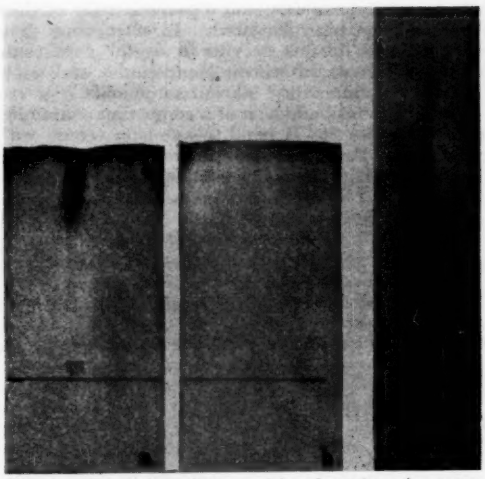

Fig. 1. Cross-linkage tests on 1-in. chromatography paper (Whatman No. 1). Origins are marked by horizontal pencil lines: the varnish fragments were placed just above these lines in (*a*) and (*c*). Solvent flowed upwards.
(*a*) A methacrylate polymer after being heated for 4 hr. at 155° C. Solvent and stain: benzene with 0·015 per cent sudan IV. (*b*) Blank strip for comparison. (*c*) Polyvinyl acetate after the same treatment as (*a*). Solvent: methanol. Light green was used as a paper stain so that leaching could be followed, but the resin was positively indicated by spraying with equal volumes of 5 per cent cerium nitrate and 0·1 *N* iodine

A long streak of soluble polymer moves along the paper so long as leaching continues, and ends fairly abruptly, to form a rounded tail, when all soluble polymer has been removed from the varnish fragment. The process is stopped as soon as the tail is clearly separated from the origin. Any polymer rendered insoluble by cross-linkage remains unmoved at the origin, so that the outline of the original fragment is sharply visible. This can be seen in Fig. 1(*a*), where a proportion of the polymethacrylate is cross-linked. The soluble portion forms a tail just behind the solvent front. Measurements by an interference method of the contraction in thickness suggest that about a third of the film has been rendered insoluble. Absence of resin at the origin in Fig. 1(*c*) indicates that none of the polyvinyl acetate has become cross-linked.

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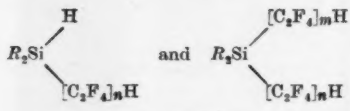
Free Radical Reactions with Inorganic Covalent Hydrides: a Route to Polyfluoroalkyl Silicon Compounds

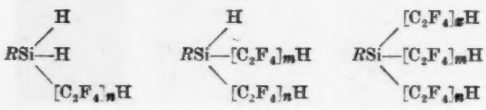
THE reactions of hydrocarbon free radicals are reasonably well established, but much less is known about the reactions of inorganic free radicals based on elements such as bismuth, silicon, germanium, lead, zinc, phosphorus, arsenic, tin or aluminium. The relative stabilities of some of these radicals can be predicted with reasonable certainty. The $SiCl_3$ radical, for example, should be similar in type to the CF_3 or CCl_3 radical, and it is not surprising that trichlorosilane reacts with olefins[1,2] to give $SiCl_3.[olefin]_n.H$; thus tetrafluoroethylene[2] yields $SiCl_3.[CF_2.CF_2]_m.H$, where $m = 1$–4.

Alkylsilyl radicals should be more reactive than trihalogenosilyl radicals, and a general study of their chemistry has been initiated. In particular, their reactions with olefins provide a useful new route for the synthesis of silicon compounds, and especially of polyfluoroalkyl silicon compounds.

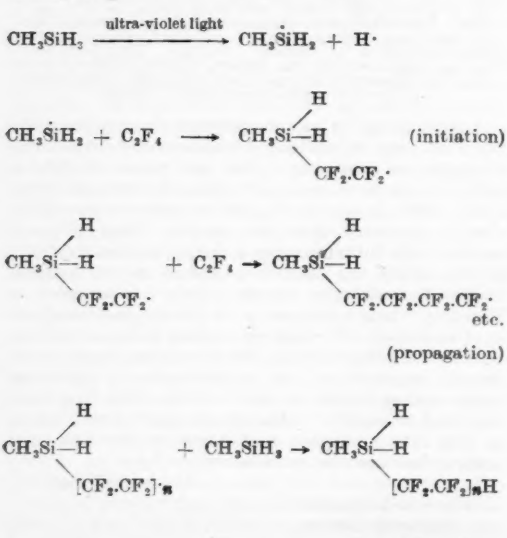
The free radical addition of a compound containing more than one Si—H bond to an olefin occurs with great ease. Thus with tetrafluoroethylene, dialkylsilanes, R_2SiH_2, yield the compounds



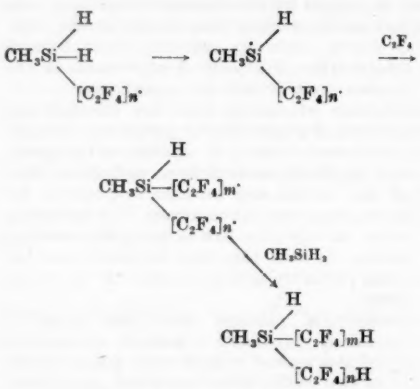
and alkylsilanes, $RSiH_3$, yield the compounds



by very rapid quantitative chain reactions; for example:

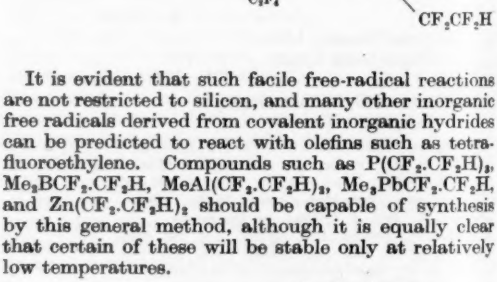


The value of n can be controlled by the ratio of reactants used, and the compound where $n = 1$, for example, has been obtained in 63 per cent yield. It is noteworthy that under normal conditions the above propagation step proceeds in preference to initiation of new chains involving the second or third Si—H bonds:



Compounds containing more than one polyfluoroalkyl group attached to silicon are produced by the further reaction of the initial product $CH_3SiH_2[C_2F_4]_nH$ with tetrafluoroethylene; that is, mixed carbon-silicon di-radicals are not involved in the reaction.

The compound in which $n = 1$ can be made to react further with the same or a different olefin, so that a wide variety of silicon compounds can be obtained by this method; for example:



It is evident that such facile free-radical reactions are not restricted to silicon, and many other inorganic free radicals derived from covalent inorganic hydrides can be predicted to react with olefins such as tetrafluoroethylene. Compounds such as $P(CF_2.CF_2H)_3$, $Me_2BCF_2.CF_2H$, $MeAl(CF_2.CF_2H)_2$, $Me_3PbCF_2.CF_2H$, and $Zn(CF_2.CF_2H)_2$ should be capable of synthesis by this general method, although it is equally clear that certain of these will be stable only at relatively low temperatures.

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'Acceleration' of Chemical Reactions

In a recent monograph on the thermodynamics of irreversible processes, Prigogine[1] has investigated in some detail the time variation of the entropy production (d_i^2S/dt^2). An examination of the implications of the general theory for the case of a chemical reaction leads to some interesting new concepts.

The entropy production at any particular time is given by

$$\frac{\mathrm{d}_i S}{\mathrm{d}t} = \frac{1}{T} Av \qquad (1)$$

where T is the absolute temperature, v the reaction velocity at that moment and A the instantaneous affinity defined as $-\sum_i \nu_i \mu_i$ (ν_i is here the stoichiometric coefficient and μ_i the instantaneous chemical potential of the i^{th} component involved in the reaction). The coefficients ν_i are positive for products and negative for reactants.

On differentiation of equation (1)

$$\frac{\mathrm{d}_i^2 S}{\mathrm{d}t^2} = \frac{1}{T} (A\dot{v} + \dot{A}v) \qquad (2)$$

where, in general, $\dot{v}$ and $\dot{A}$ represent differential coefficients with respect to time. We now propose to term the quantity $\dot{v}$ the 'acceleration' of a chemical reaction. This conception is valid only when the reaction velocity is not constant; otherwise, of course, $\dot{v} = 0$.

Utilizing Prigogine's theorem that the contribution to the rate of change of the entropy production per unit time by the rate of change of the generalized 'force' is equal to the contribution due to the 'acceleration', we obtain from equation (2)

$$A\dot{v} = \dot{A}v \qquad (3)$$

The reaction velocity v may be expressed as the rate of change of the 'degree of advancement' of the chemical reaction, ξ. Thus,

$$v = \frac{\mathrm{d}\xi}{\mathrm{d}t} \text{ and } \dot{v} = \frac{\mathrm{d}^2\xi}{\mathrm{d}t^2}$$

$\mathrm{d}\xi = \mathrm{d}n_i/\nu_i$, where n_i is the mole number of the i^{th} component.

The affinity A is a function of the variables of state p (pressure), T (temperature) and ξ. At constant pressure and temperature,

$$\dot{A} = \left(\frac{\partial A}{\partial \xi}\right)_{p,T} \frac{\mathrm{d}\xi}{\mathrm{d}t}$$

and equation (3) becomes

$$A\dot{v} = \left(\frac{\partial A}{\partial \xi}\right)_{p,T} v^2$$

Hence,

$$\dot{v} = \left(\frac{\partial \ln A}{\partial \xi}\right)_{p,T} v^2 \qquad (4)$$

It is this equation (4) that provides us with an explicit relation for the 'acceleration' of a chemical reaction.

In addition, Prigogine has established a general theorem which, for our purposes, may be expressed as

$$v\dot{A} \leqslant 0 \qquad (5)$$

or by

$$v^2 \left(\frac{\partial A}{\partial \xi}\right) \leqslant 0$$

However, since v^2 is always a positive quantity, the above relation implies that

$$\left(\frac{\partial A}{\partial \xi}\right)_{p,T} \leqslant 0$$

that is, the affinity decreases during the course of a chemical reaction and, at equilibrium, $A = 0$,—a result well known to workers in chemical thermodynamics.

Moreover, extending the foregoing theory, we find, from equations (3) and (5),

$$A\dot{v} \leqslant 0 \qquad (6)$$

and the 'acceleration' of a chemical reaction has, in general, the opposite sign to the affinity.

These results may easily be generalized to several simultaneous, accelerated reactions by following the usual methods as outlined by Prigogine.

To sum up: some of the basic properties of the newly defined 'acceleration' of a chemical reaction—equation (4)—have here been developed for those cases where Prigogine's theorems are applicable, that is, under certain restrictive conditions indicated in his work.

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'Macrocrystalline' Carbon

From a mathematical analysis of the X-ray diffraction patterns of products obtained at various stages during the graphitization of carbon, Franklin[1], and later Houska and Warren[2], have shown that only two carbon interlayer spacings are possible: 3·35 A. for the orientated stacking in graphite, and 3·44 A. for the random orientation of the planes in carbon. Precise measurement of the interlayer spacing of cokes and carbons is not possible because of the very diffuse nature of the diffraction maxima, and it is therefore of interest to report that 'macrocrystalline' carbon with an interlayer spacing of 3·45 A. has been prepared by sublimation of artificial graphite under high vacuum. The material, as deposited, has a nodular surface with a grey metallic sheen. It has a low porosity, a hardness of between 1 and 2 on the Moh scale (compared with a value of less than 1 for graphite) and a true density of 2·22. The carbon content is greater than 99 per cent and the ash less than 0·4 per cent. The carbon planes of the individual crystallites are found to lie very approximately

parallel to the surface on which deposition occurs, and the crystallite size, as shown by the sharpness of the lines in the diffraction pattern, is similar to that of artificial graphite. A diffraction pattern of this material together with patterns of graphite and a sample found to be a mixture of the two phases is shown in Fig. 1.

Contrary to expectation, this material did not graphitize readily. Prolonged treatment with strong sulphuric acid containing a little nitric acid had no effect, and temperatures in the range 2,800–3,000° C. were needed to convert a sample into graphite.

The hardness and stability of this compound suggest cross-linkage between the carbon-layer planes. Whatever form this linkage takes, the graphite layers must still be largely retained, and it must exist without introducing sufficient 3-dimensional order to give any general (*hkl*) reflexions. The method of preparation and purity of the compound make it necessary for the cross-linkage to be through carbon atoms, and some system similar to that suggested by Gibson, Holohan and Riley[3] may exist.

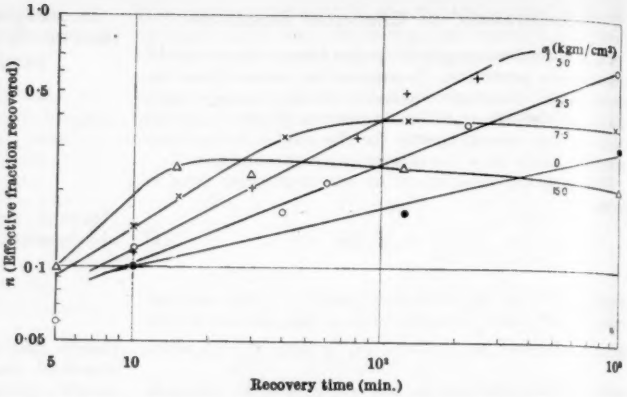

Fig. 1. Degree of recovery, represented by n, plotted against the recovery time for various levels of fatigue stress

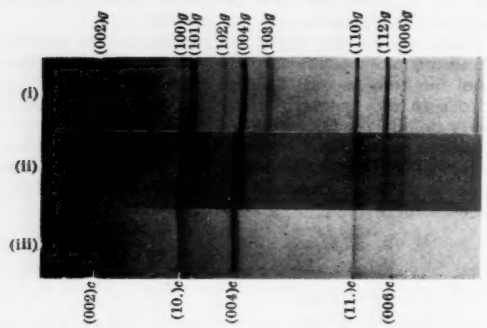

Fig. 1. (i) Natural graphite; (ii) mixture of graphite and macrocrystalline carbon; (iii) macrocrystalline carbon

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Effect of Fatigue Stresses on the Recovery Properties of Metals

In order to examine the nature of the interaction between the processes of creep, fatigue and recovery, some preliminary experiments have been conducted at room temperature on metals of low melting point. The tensile creep stress in these experiments was imposed by means of a mechanical spring system. The fatigue stress (also tensile) was applied by an electromagnetic vibrator and was detected and measured using a barium titanate crystal incorporated in the specimen grips.

A low-level sinusoidal fatigue stress (of about 300 c./s.) superimposed on the static creep stress increases the creep-rate of lead markedly. This phenomenon has already been observed by Greenwood[1]. In the present case, the measurements show that this increase is considerably greater than that resulting from applying the peak stress (static stress plus fatigue stress amplitude) statically. The most interesting results, however, are those which relate to the recovery processes. The investigation has been confined, to date, to the recovery of the transient creep properties during the unstressed period of an interrupted creep test. The degree of recovery that occurs may, of course, be deduced from the subsequent creep behaviour on reloading. All the specimens were subjected to a fixed amount of creep, under fixed conditions of stress and temperature, prior to the recovery period (ρ). The stress conditions applied during this period were varied, for the different tests, and an index of recovery, n, was deduced from the subsequent creep curve. The use of this index has been demonstrated elsewhere[2]; it is sufficient to say here that it represents the magnitude of the transient creep component on reloading by expressing this as a fraction of the original component for the fully annealed metal. Thus if the original transient creep is expressed in the usual power-law form by $\varepsilon = \beta_1 t^m$, where ε is strain and t the time, β_1 and m being constants, and if the 'recovered' component, exhibited on reloading, is given by $\beta_2 t^m$, then $\beta_2/\beta_1 = n$.

The results of a series of experiments on lead are given in Fig. 1. If no fatigue stress is imposed during the recovery period, we obtain a linear relationship between log n and log ρ, with a slope of about 1/3. This is in accord with previous work[2]. As the fatigue stress is increased, the rate of recovery at first increases; but eventually a second process, which has the characteristics of hardening, occurs. This slows up, or reduces, the total recovery observed. At higher fatigue stresses, the metal either fails by fatigue during the recovery period or fails shortly after reloading. The acceleration of recovery by the fatigue stress is similar to that observed in copper and other metals, using hardness as an index[2]. No previous observations appear to have been made on the

transient creep recovery. This also appears to be the first observation of a 'mechanical re-hardening' under fatigue stresses.

Any adequate theory for these observations must take account of these two broad effects, acting in opposition. The present state of dislocation theory offers a reasonable basis for their interpretation. This may be very briefly summarized as follows. Dislocation jogs are formed by the intersection of dislocations during the creep process. These jogs, in motion, can generate vacancies (or interstitials). Such generation occurs, therefore, under the alternating stresses during the recovery period. The increased number of vacancies generated increases the probability of their diffusion to dislocations, and hence the probability of dislocations climbing. The rate of polygonization, which is controlled in part by the climb process, is therefore accelerated. This, then, is a possible mechanism for increased recovery. On the other hand, these same vacancies contribute to work-hardening by impeding dislocation motion, particularly when they form clusters, and over prolonged times this second process reduces the effects of the first. Ultimately the metal fails in fatigue by the growth of a crack initiated from a vacancy cluster, probably aggregated by dislocations acting as carriers.

It is interesting to compare results obtained in a very different field[4]. An initial softening of sodium chloride single crystals irradiated by 50-kV. X-rays was followed by a hardening over very prolonged times. This appears to be similarly explicable in terms of the vacancies created by the irradiation.

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Flow-Birefringence and Stress

IN a recent communication[1], Dr. A. S. Lodge proposed: (*a*) to equate the extinction angle χ in flow-birefringence with the direction of the principal tensile stress, and (*b*) that the degree of birefringence Δn is proportional to the magnitude of the difference of the principal tensile and compressive stresses ΔP. For *plane* simple shear, $\Delta P \times \sin 2\chi = 2\tau$ or $\tan 2\chi = 2\tau/(\sigma_x - \sigma_y)$, where τ is the measured shear stress, $\sigma_x - \sigma_y$ the difference in 'normal stresses', both of which can be derived by various methods, for example, using Mohr's circle[2].

Lodge mentioned the possibility of the experimental proof of this assumption by simultaneous measurements of both the flow-birefringence and the normal stress $\sigma_x - \sigma_y$ ($= P_{11} - P_{22}$) using the Weissenberg rheogoniometer[3].

We investigated this possibility on a 15 per cent solution of *P*-100 poly*iso*butylene in decalin (maximum viscosity approximately 10,000 poises or a relative viscosity of $\sim 10^6$) at 30° and 50° C. in a range of rates of shear, D, from 0·007 to 4·5 sec.$^{-1}$. Three sets of experiments with separate instruments were run: (1) flow-birefringence tests, giving Δn and χ as functions of D; (2) 'flow curves' giving the shear stress τ as a function of D; and (3) 'normal stress' experiments giving $\sigma_x - \sigma_y$ as a function of D from measurements of the total thrust F, divided by the area (πR^2) of the plate in the cone-and-plate arrangement[4], $\sigma_x - \sigma_y = \dfrac{2F}{\pi R^2}$. We then made the following checks:

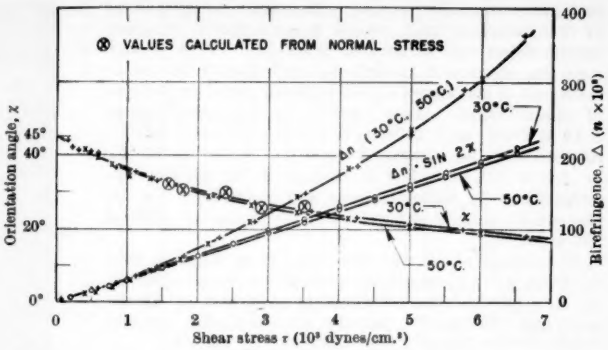

Fig. 1

(*a*) According to Lodge's assumption, Δn should be proportional to Δp for any solution, a relationship that was derived by Kuhn and Grün[5] and generalized by Treloar[6] for the stress-birefringence of highly elastic materials, such as rubber. As Lodge states, the identical relationship has been derived by Kuhn and Kuhn[7] for the flow-birefringence of an infinitely dilute solution of free-draining coiled molecules. As seen in Fig. 1, this proportionality is valid in the whole range of rates of shear investigated at both temperatures. The plot of Δn vs. τ proposed by Peterlin and Signer[8] is definitely curved upwards.

(*b*) The calculated values of χ from the normal stress measurements are plotted in Fig. 1 as circles: they check within 1° with the χ-values determined from the flow-birefringence experiments.

These checks show that the basic assumption of stress-birefringence of solids, that is, the proportionality of Δn and the difference of the principal stresses, is equally valid for the flow-birefringence of polymer solutions. The angle χ, giving the direction of the principal tensile stress, can be used to calculate the normal stress from the shear-stress and vice versa.

These checks probably will allow the well-developed results for the rheology of rubber (incompressible materials characterized by one shear modulus)—a 'continuum-mechanical theory' that has been summarized in Treloar's book—to be applied to the problem of the elasticity of flowing solutions of polymers, which have been treated hitherto by 'molecular theories'.

The proportionality constant, C, between Δn and ΔP:

$$C = \frac{\Delta n}{\Delta p} = \frac{2\pi}{45} \frac{(n^2+2)^2}{n} \frac{\alpha_1 - \alpha_2}{kT}$$

depends essentially on the polarizabilities α_1 and α_2 of the monomer unit, which are calculable to some degree from the structural formula[9]. This would lead one to expect Lodge's result, namely, its independence of concentration of polymer and distribution of chain-length. Our values for $(\Delta p/\Delta n)T$ were $2{\cdot}14 \times 0{\cdot}10^7$ and $2{\cdot}04 \times 0{\cdot}10^7$ for 30° and 50° C. respectively, as compared with $2{\cdot}1 \times 10^7$ at 30° C. or $2{\cdot}3 \times 10^7$ at −35° C. measured for solid poly-*iso*butylene by Stein, Holmes and Tobolsky[10]; n for the solid polymer is approximately equal to that of the solution.

A comparison of the viscosity, η, at a given rate of shear, to the maximum value at low rates of shear, η_0, showed that the relationship proposed by Buchheim and Philippoff[11], namely, $\eta/\eta_0 = \sin 2\chi$, was not valid, η decreasing faster than $\sin 2\chi$ with D.

A check of the numerical evaluation of the theory of prolate ellipsoids published by Scheraga[12] showed that a proportionality between Δn and τ exists until

$$\alpha = \frac{\text{rate of shear}}{\text{rotational diffusion constant}} \approx 5,$$ or until

$\chi \approx 25°$, not the one between Δn and Δp. $\eta/\eta_0 = \sin 2\chi$ is valid in the whole range with deviation of only a few per cent. Whether this is a result of the assumptions in the mathematical theory or is due to a basically different mechanism of flow cannot yet be decided.

Further tests on the dynamic properties of the same solution (dynamic shear modulus and dynamic viscosity) over a wide range of frequency gave values not directly comparable with that calculated from the flow experiments, pointing to an obvious gap in the theory of such comparisons.

A more extensive publication will follow in the *Journal of Applied Physics*, following a paper presented at the meeting of the American Physical Society, High Polymer Physics Division, in Pittsburgh, Pa., on March 16, 1956.

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Differential Sputtering of Grain Boundaries in Polycrystalline Tin

It has been reported[1] that in a polycrystalline aggregate the properties of grain boundaries such as precipitation and chemical etching depend upon the difference in orientation of the adjoining grains. During our studies of cathodic sputtering of polycrystalline tin, we have observed differential etching from boundaries forming tricrystals[2]. Further work has shown that this differential etching can be correlated with the varying density of dislocation along the boundaries.

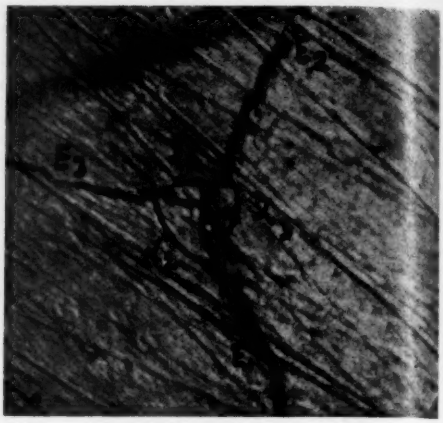

Fig. 1

A specimen of high-purity well-annealed polycrystalline (white) tin was polished mechanically. It was subjected to slow sputtering in a flushing atmosphere of argon (pressure about 0·1 mm.) employing the usual technique. The cathode–anode gap was 1·2 cm. and the applied rectified potential was 500 volts. Fig. 1 (× 100), showing a typical micrograph of the sputtered surface, is representative of a large number of results.

The dihedral angles, α, between the tricrystal boundaries were measured close to the junction within an accuracy of 1°. The relative grain-boundary free energies E were calculated by the expression

$$\frac{E_1}{\sin \alpha_1} = \frac{E_2}{\sin \alpha_2} = \frac{E_3}{\sin \alpha_3}$$

We have assumed the energy E_1 of the most etched boundary arbitrarily to be unity. The difference of orientation, θ, between the adjoining grains was obtained from Aust and Chalmers's data[3] for the grain boundary energy vs. small angle of misfit for white tin. The Burgers vector b is taken as 5·831 A. Using the dislocation model of a simple grain boundary, the relative dislocation densities ($= \theta^2$ rad/b^2) along the tricrystal boundaries have been evaluated (see Table 1).

It is easy to see that the sputtering of the grain boundaries depends upon the density of dislocations, those with higher densities of dislocation having sputtered to a greater extent. The results support the 'transition lattice' theory of the grain boundary.

Thanks are due to the Council for Scientific and Industrial Research, Ministry of Education, Government of India, and the Scientific Committee, Uttar Pradesh, for support of the research schemes,

Table 1

Grain boundary	Opposite dihedral angles ($\alpha°$)	Relative boundary energies (E)	Relative difference in orientation ($\theta°$)	Relative densities of dislocation
Most etched	$\alpha_1 = 101$	$E_1 = 1{\cdot}000$	9·0	$7{\cdot}26 \times 10^{12}$/cm.^{2}
Moderately etched	$\alpha_2 = 117$	$E_2 = 0{\cdot}908$	6·6	3·90
Least etched	$\alpha_3 = 142$	$E_3 = 0{\cdot}626$	3·1	0·86

and to the Physics Department, University of Lucknow, for facilities for this work. One of us (B. D. S.) wishes to thank the Scientific Research Committee, Uttar Pradesh, for the award of a research assistantship.

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Influence of Trace Electrolytes on Interfacial Tensions at the Oil/Detergent Solution Interface

Recently, there has been some discussion between Brady, Pethica, Cockbain and others regarding the form in which the Gibbs adsorption isotherm should be applied to surface-active electrolytes in the absence of any added electrolyte. Under such conditions, and assuming complete dissociation of the surface-active electrolytes, it has been shown, for example[1], that the Gibbs equation (neglecting the correction for activities) may be written in the form

$$\frac{2\,kT}{A} = -\,c.\frac{d\gamma}{dc} \qquad (1)$$

where γ is the interfacial tension; c the concentration of surface-active electrolyte; A the area occupied per film ion at the interface; k the Boltzmann constant, and T the absolute temperature. This has been verified by Cockbain[2] for sodium dodecyl sulphate at the oil–water interface. Other investigators, however, have found[3,4] that the form theoretically applicable in the case of excess added electrolyte, namely,

$$\frac{kT}{A} = -\,c.\frac{d\gamma}{dc} \qquad (2)$$

appears also to apply in practice to the case of no added electrolyte.

While studying the interfacial tension behaviour of ionic detergents adsorbed at an oil (petroleum ether, b.pt. ~ 120° C.)–water interface a curious effect was observed, which may well reconcile these discordant results both with each other and with theory. Four systems have been investigated, namely, sodium dodecyl sulphate and dodecyltrimethylammonium bromide each in aqueous solution and in 0·1 *M* sodium chloride. Interfacial tensions were determined by a drop volume method.

The results for each detergent in 0·1 *M* sodium chloride appeared normal. Ageing was appreciable only at very dilute concentrations ($\sim 10^{-5}$ *M*). In aqueous solution, however, the results depended on the purity of the water used.

In the first series of experiments the aqueous solutions were made up with water from a standard Manesty still (specific conductance $\sim 4 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$). Ageing effects extending over hours were observed with sodium dodecyl sulphate at all concentrations studied ($\sim 10^{-2} - 10^{-4}$ *M*) and with dodecyltrimethylammonium bromide at concentrations $\sim 10^{-3}$ *M*. This work was repeated using the same water redistilled from a glass still and freshly boiled to remove carbon dioxide (specific conductance $\sim 2 \times 10^{-6}$), but little improvement was noted.

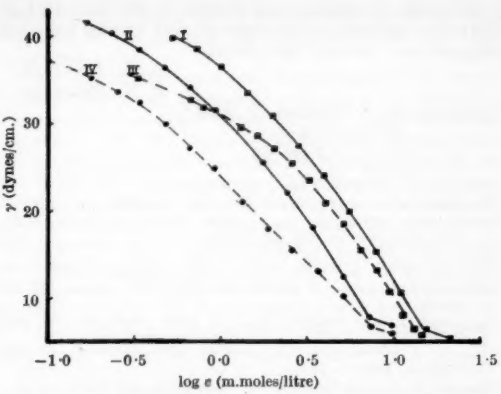

Fig. 1. Interfacial tensions of sodium dodecyl sulphate and dodecyltrimethylammonium bromide at the petroleum ether–water interface.
I, Dodecyltrimethylammonium bromide in water passed twice through a column of 'Biodeminrolit'; II, sodium dodecyl sulphate in water passed twice through a column of 'Biodeminrolit'; III, dodecyltrimethylammonium bromide in glass-distilled water; IV, sodium dodecyl sulphate in glass-distilled water

Finally, the Manesty-distilled water was passed twice through a column of ion exchange resin ('Biodeminrolit') and collected in polythene vessels (specific conductance $\sim 0{\cdot}9 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$), no special precautions being taken to exclude carbon dioxide or ammonia present in the atmosphere. In this instance little ageing was observed except in very dilute solution, and the γ-log$_{10}c$ curves obtained (Fig. 1) were found to be displaced from the original curves towards higher interfacial tensions at comparable concentrations.

Surface potential studies with dodecyltrimethylammonium bromide by us (which will be described elsewhere) permitted the surface area (A) occupied per film ion to be determined independently of the Gibbs equation, thus enabling the correct form of the Gibbs equation to be found. It was found that with glass-distilled water the $1.kT$ form (equation (2)) applied, while with ion-free water the $2.kT$ form (equation (1)) was appropriate. This suggests that glass-distilled water contains a swamping excess of electrolyte, but the conductivity values indicate this is not so. We must conclude, therefore, that this anomalous behaviour in normal distilled water is due to a specific adsorption at the interface of one or more trace counter ions present in the bulk, although no attempt has been made to determine the nature of these ions. Likewise, the long ageing effects can be attributed to the slow adsorption of the trace counter ions from the bulk of the solution.

Thus the disagreement regarding the appropriate form of the Gibbs equation to be applied to surface-active electrolytes in the absence of added electrolyte may be due merely to the purity of the water employed by the different investigators. In conclusion, it may be added that the results reported here for ionic detergents add to the extensive literature already available, for example, on the sensitivity of monolayers in general[5–9], and carboxylic soap films in particular, to trace electrolytes.

We wish to express our thanks to Sir Eric Rideal for many interesting discussions, and for the valuable suggestions arising therefrom.

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London. June 28.

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'Continuous' Intensities in the Soft X-Ray Region

The generally accepted empirical law relating the intensity of the 'continuous' X-radiation with energy and atomic number, $I = kZV^2$ (for constant current), is known to apply to the 'hard' X-ray region; but its validity has never been established in the 'soft' X-ray region. The classical experiments which established it were done with deep ionization chambers; the integrated intensity over the whole band of emitted wave-lengths as well as the intensity at any arbitrary wave-length over the range were found to fulfil the above law approximately.

We have attempted to see how far this law was obeyed in the soft X-ray region using a 15-stage beryllium–copper photomultiplier in vacuum as detector, together with a d.c. amplifier as recorder of the total radiation emitted from the target. Our experiments were confined to two types of thick target—copper and carbon—over a range of energies from 200 V. to 8,000 V., that is, from thresholds of 62 A. to 1·5 A. respectively. Previous experiments with photographic plates had shown that 'background' radiation was emitted over a wide range of wave-lengths from the 'threshold' to well over 500 A.; this was superimposed on the characteristic soft X-radiation from the target. The latter occurs for copper at about 13 A. and 170 A. for the *L* and *M* bands respectively, while the *K* radiation of carbon was excited at about 45 A.

In order to avoid spurious results, the targets were bombarded at a red heat in vacuum for several periods of 15 min. each, before making observations; the surface, conditioned in this way, gave repeatable results over the time taken by the observations, which was generally a few minutes. The choice of working conditions was facilitated by having the target rotatable on a ground joint so that the angle of optimum intensity through the main and subsidiary slits (0·1 mm. and 5·0 mm. respectively) could be accurately set, to give a maximum of intensity for all the wave-lengths emitted into the photomultiplier. This is usually close to grazing incidence.

The procedure adopted was to apply a constant voltage to the target and vary the current, noting the d.c. output response. This was repeated over the whole range explored. All the results both from 'contaminated' and clean targets showed that for any fixed voltage the X-ray output is directly proportional to the current. However, for any fixed current, the output is approximately proportional to the *first* power of the voltage. This is illustrated in Fig. 1, where log intensity is plotted against log voltage for two different current values in the case of clean targets of copper and carbon. Except for the lowest energy points for carbon at 200 volts, the slope is about 1·15, so that in this region of soft X-rays, the 'square' law does not appear to be valid.

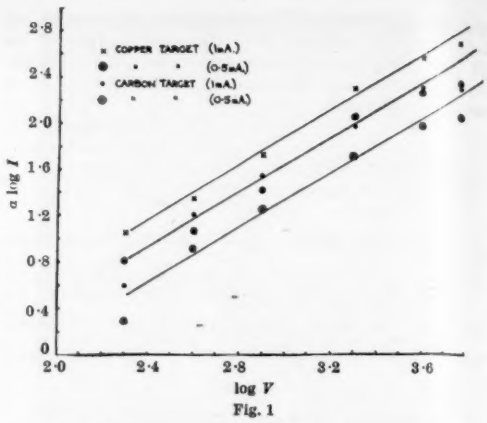

Fig. 1

It will also be seen that the dependence on atomic number is no longer given by the empirical relation, for the ratio decreases from about 3 at the lowest energy to about 2 for medium and high energies in the range chosen. It is hoped to publish fuller details at a later date.

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Importance of Gas Spaces in the Propagation of Detonation of Granular Explosives

It has been suggested that in low- and medium-velocity detonation in condensed explosives, propagation may be due to heating in the shock front of gas entrapped in the explosive[1]. The temperature in these gas pockets has been shown to be very high[2], and the hypothesis is confirmed by the known effect of increase in gas pressure in stopping detonation in certain granular explosives[1]. The temperature attained in the gas depends on the compression ratio and the ratio of the specific heats of the gas, γ. If the hypothesis is correct, increase of γ should cause an increased temperature, and hence an increased rate of reaction, which should be manifested as an increase in the velocity of detonation of the explosive fired at cartridge diameters below that required for maximum velocity. We have now demonstrated this effect experimentally.

We have examined the effect of replacing air ($\gamma = 1{\cdot}40$) by argon ($\gamma = 1{\cdot}67$) as the surrounding medium on the velocity of detonation of two granular explosives. These were granular T.N.T. (Grade 1, 22–30 B.S.S.) of density 1·00 gm./cm.^{3} and cartridge diameter 1¼ in., and an 82/18 mixture of ammonium nitrate (specific surface 1,200 cm.^{2}/gm.) and alum-

inium (specific surface 1,600 cm.²/gm.) of density 0·75 gm./cm.³ and cartridge diameter ¾ in. The velocity of detonation was measured photographically.

For the T.N.T. the velocity of detonation in air was 1,380 ± 20 m./s., and in argon 1,580 ± 15 m./s. For the ammonium nitrate composition, the velocities were 2,850 ± 30 m./s., and 3,100 ± 30 m./s., respectively, the limits quoted being standard deviations. There is clearly a significant increase in velocity, which further confirms the view that the mechanism of propagation of detonation involves heating of the gas spaces by the shock front.

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Effect of Lightning Discharges on Magnetographs

Chaubal, Deshmukh and Malurkar[1] recently reported an instance of "minor oscillations" recorded particularly by the La Cour *H* and *D* magnetographs of the Alibag Observatory during a thunderstorm which passed over Alibag on June 2, 1955. They were interested to know if similar observations were available from other observatories.

Since 1952, two complete sets of photographically recording magnetographs, one Watson and the other La Cour, have been functioning regularly in the Magnetic Section of the Kodaikanal Observatory. During the past four years or more, in the thunderstorm seasons, I have often noticed in the traces of these magnetographs oscillations of precisely the same character as reported by Mr. S. L. Malurkar and his co-workers. I have always thought them to be caused by lightning discharges. However, I have now examined all our La Cour and Watson records from 1952 to date in order to check the correctness of the impression that these characteristic oscillations are of rather common occurrence and are indeed associated with thunderstorms. In our records there are some dozens of instances of such oscillations which correspond with thunder and lightning reported by our weather observer. There are also some instances in which similar, though usually less-marked, oscillations are noticeable, but no corresponding thunderstorms are recorded in the weather observer's diary. The cause of these latter oscillations is obscure; perhaps, during the normal watch hours the weather observer has not noticed the somewhat distant or minor lightning discharges, and presumably has not reported all the thunderstorms that may have occurred late in the night. It is also not impossible that some of the very feeble oscillations are due to the momentary, but heavy, direct current which the battery supplies to the self-starter of a motor-car engine starting up rather close to the magnetic observatory. However, in all cases in which there is correspondence between the magnetic oscillations recorded and the lightning reported there can be little doubt but that it is the short-duration electric currents accompanying lightning strokes which are responsible for the perturbations recorded by the magnetographs.

The variometer room at Kodaikanal is a very substantially built, thermally well-insulated chamber with a thick roof and heavy double walls of stone masonry. Both the Watson and La Cour variometers are installed on piers supported by the masonry floor in exactly the same manner. The sensitivity (taken to mean the ability to respond fully to a variation of duration comparable or greater than the period of the instrument) of the Watson *HF* instrument is considerably higher than that of the corresponding La Cour instrument. It does not seem that the method of mounting of a magnetograph has much to do with its capacity for recording the oscillations caused by impulsive lightning discharges.

From Kodaikanal records it is clear that often the magnetic oscillations due to lightning strokes occur simultaneously in all the three traces (*H*, *D* and *V*) of the La Cour variometers, although the amplitudes are different in the three components, evidently because the corresponding intensities are also different. We have many instances in which the Watson instruments (especially *H* and *D*, the performance of the *VF* instrument being often unsatisfactory) have also recorded such oscillations during thunderstorms; but these oscillations have smaller amplitudes than those recorded by the La Cour variometers, and are very much damped. These differences are evidently attributable to the fact that compared to the La Cour variometers the Watson magnetographs have considerably greater inertia and higher damping.

I am indebted to Mr. R. V. Subramanian for assistance in examining the magnetic records.

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Vowel Sounds and Perceptual Constancy

It has been known for some time that vowels are distinguished from one another mainly by the frequencies of the formants or regions of the auditory spectrum in which there is a comparatively large amount of energy. Recently, the hypothesis has been put forward by Joos[1] that when a listener identifies the vowel in a particular word he does so not by considering the absolute value of the lowest two formant frequencies, as was previously thought, but by assessing the frequencies of these formants in relation to the formant frequencies of other vowels which he has heard pronounced by that speaker. On this hypothesis, the identification of a particular sound depends on the acoustic structure of the neighbouring sounds.

A similar process is known to occur in the perception of other kinds of sensory data. Thus in visual experiments the same response, 'white', may be given to a piece of paper in sunlight and in an artificially lighted room, despite the wide differences in the spectra of the light reflected from the paper: the other neighbouring stimuli compensate for the differences[2].

It has recently become possible to demonstrate the auditory phenomenon with the aid of synthetic speech, which can now be precisely controlled and

yet sound so natural that it is invariably confused with ordinary recorded speech. The instrument accomplishing this is the Parametric Artificial Talking Device of the Ministry of Supply Signals Research and Development Establishment. The sounds of most utterances can be specified in terms of six variables. Three of these are the formant frequencies: the other three are the intensity of the voicing; the intensity of the fricative noise which is present in some sounds such as *s*; and the fundamental frequency, which determines the pitch of the utterance. In the Parametric Artificial Talking Device, complex sounds are synthesized in accordance with the variations of these six parameters as functions of time.

In the current experiment, two versions of the phrase *Please say what this word is* were synthesized. The two versions were the same except in the range of their first formants, which were as shown in Table 1. Each version was followed by an identical test sound, which was a word of the form *b*-(vowel)-*t*. Recordings of these sentences followed by the test word were played to fifteen subjects, the playings being separated by at least five minutes. The subjects were asked to indicate whether the last word was *bit*, *bet*, *bat* or *but*. Fourteen of them reported hearing different words in the two cases, despite the identical physical stimulus. The experiment was repeated on fifteen different subjects, but with a ten-second silent interval between the introductory sentence and the test word. In this case only seven subjects described the words as different; the difference between the two groups is significant, $p < 0{\cdot}01$ by the exact treatment of a 2×2 table.

Table 1. Distribution of Responses from Thirty Subjects

Preceding words with	Test word heard as *Bit*	*Bet*	*Bat*
First formant, 300–675 c.p.s.	20	10	0
First formant, 150–400 c.p.s.	0	19	11

This establishes that there is an auditory parallel to the visual constancy effects cited earlier. Furthermore, the slight differences present in the auditory case may allow fresh experiments to reveal the mechanism of these constancy phenomena. Unlike the visual case, the auditory one allows interpolation of other voices, skewing of the distribution of preliminary stimuli, and similar experiments directed at comparing constancy phenomena with data on level of adaptation in psychophysics[3].

Finally, the experiment also demonstrates the value of a speech synthesizer, since comparable control of the stimulus could not be achieved using a live voice. The psychological and phonetic implications of these results are now being followed up in further experiments using synthetic speech.

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University of Edinburgh.

W. Lawrence
Ministry of Supply
Signals Research and
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June 5.

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"Automation Economics"

In his review of my book "The Economic Consequences of Automation" (September 1, p. 444), Mr. Austen Albu, while giving me credit for the originality of my argument on the inflationary effect of the pipeline-lag between input and output during periods of increasing production, accuses me of having contradicted my own theory. He states that the argument conflicts with my view that automation reduces the extent of inflation by raising the output of goods and reducing the need for labour.

Mr. Albu should have noticed, in my chapter entitled "Deflation or Inflation?", the following sentence: "It is our contention that, provided that there is an increase in the *aggregate* cost of production, the increase in the output is likely to be preceded by an increase in prices, even if there is a decline in the cost per unit" (p. 77).

The word 'aggregate' was italicized in the book. Had he noticed it, he could not possibly have attributed to me the categorical view that automation reduces the extent of inflation. It depends on how automation affects the aggregate cost of production as distinct from cost per unit of output. My attitude is defined even more clearly in the following passage: "In so far as the grand total paid out for raw materials, transport, wages, etc., is reduced [by automation] it results in a reduction in total income and consumers purchasing power, and should therefore tend to produce a deflationary effect. If, however, the total is increased, then the effect of automation will be inflationary even if the cost of production is reduced. . . . For during the 'pipeline-lag' described above, the volume of consumer purchasing power will increase without being accompanied by a corresponding increase in the volume of goods available to consumers" (p. 80).

Throughout the book I endeavoured to avoid answering with a dogmatic 'yes' or 'no' the large number of questions raised by automation in the economic sphere. I gave a list of influences working in favour or against inflation, deflation, unemployment, capital requirements, etc. A reviewer could easily single out apparently conflicting statements and accuse me of having contradicted myself: the only way in which I could have avoided this would have been by presenting only one side of the arguments. Instead, I prefer to rely on the judgment of those who will read my book with sufficient care to form a well-balanced opinion on it.

Paul Einzig
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London, E.C.4.

If one accepts Dr. Einzig's view that all steps taken to increase production are inflationary, then the only distinguishable effect of automation is, as he says on p. 84, to reduce the extent of inflation. I think that the appearance of inconsistency arises out of the impression given by the title and some of the chapters that the book is about this mysterious concept 'automation'; whereas it is, in fact, a consideration of more general economic problems.

Austen Albu
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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 15

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. A. Freeman: "Grain Storage Problems".

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mrs. E. C. Mee: "Junior School Education Today"*. (Second of eight lectures on "Problems of the Junior School". Further lectures on October 22, 29, November 5, 12, 19 and 26.)

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the North-West Kent College of Technology, Miskin Road, Dartford), at 7.30 p.m.—Prof. A. R. Ubbelohde, F.R.S.: "Melting and Crystal Structure".

Tuesday, October 16

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Taylor: "Machines and Men: The Nineteenth Century Background to Automation"*.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting. Captain A. M. A. Majendie: "The Place of Navigation in Modern Air Transport". (Presidential Address.)

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Royal Society of Arts, 6 John Adam Street, London, W.C.2), at 4 p.m.—Mr. D. R. Bomford—John Fowler Memorial Lecture.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. Gayler and Mr. H. R. C. Pratt: "Liquid–Liquid Extraction", Parts 9 and 10; Mr. H. R. C. Pratt, Mr. L. E. Smith and Mr. J. D. Thornton: "Liquid–Liquid Extraction", Part 11.

ROYAL INSTITUTE OF CHEMISTRY (at University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. P. Gray: "The Chemistry of Dinitrogen Tetroxide". (Meldola Medal Lecture.)

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. K. M. Smith: "The Electron Microscope in the Study of Viruses"*. (Second of fourteen lectures on "The Scientific Basis of Medicine".)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. A. C. Menzies: "Optics in Industry". (Further lectures on October 23, 30, and November 6.)

Wednesday, October 17

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. A. Neuberger: "The Proteins of Connective Tissue"*.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. Douglas McClean: "The Scientist as Citizen" (Presidential Address).

BRITISH COAL UTILISATION RESEARCH ASSOCIATION (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Prof. D. M. Newitt, F.R.S.: "Some Contributions of Chemical Engineering to the Processing of Coal". (Fifth Coal Science Lecture.)

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Symposium on "Artificial Insemination (Donor)"*.

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. R. C. G. Williams: "The Electronic Age". (Chairman's Address.)

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. R. Barer: "Further Developments in Quantitative Microscopy".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. M. A. Pearson: "Hydrazine as a Corrosion Inhibitor".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting with the London Section of the Royal Institute of Chemistry at the Institute of Metals, 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Mr. R. Llewelyn Davies: "Design of Research Laboratories".

Thursday, October 18

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. R. S Nyholm: "Magnetism and its Importance in Everyday Life"*.

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. E. J. Pryor and Mr. G. M. Lowe: "Changes in Copper Solubility during Flotation of Malachite"; Dr. J. M. Fletcher, Dr. D. F. C. Morris and Mr. A. G. Wain: "Outline of a Solvent Extraction Process for the Purification of Niobium from Ores or from Ferroniobium".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Harry V. Thompson: "Myxomatosis and the Rabbit in Britain"; Prof. H. R. Hewer: "The Method of Dispersal of Animals".

UNIVERSITY OF LONDON (at Goldsmiths' College, New Cross, London, S.E.14), at 5 p.m.—Prof. H. J. Eysenck: "Measuring Human Personality"*. (Second of six lectures on "Recent Pioneer Work in Education". Further lectures on October 25, November 1, 8 and 15.)

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. G. M. Binnie: "The Control, Storage and Use of Water". (Second of a series of six lectures on "The Conservation of Natural Resources".)

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. F. H. C. Crick: "The Structure and Function of Small Viruses"*. (Third of fourteen lectures on "The Scientific Basis of Medicine".)

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Dr. P. J. Rigden: "Roads and Road Problems in South Africa".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, October 19

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Experiments for the Electronics Laboratory", opened by Mr. V. Attree.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Mr. T. A. Crowe: "Motive Power on Sea and Land". (Presidential Address.)

INSTITUTION OF CHEMICAL ENGINEERS, GRADUATES AND STUDENTS SECTION (at Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m.—"Impressions of the German Chemical Industry". (Conversazione on the Overseas Industrial Tour, 1956.)

Saturday, October 20

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 2.30 p.m.—Dr. David Hamlyn: "Is a Theory of Perception Possible?"

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. Colin M. Turnbull: "Life in a Congo Village"*.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER, Grade B (honours graduate) IN PHYSICS at Brighton Technical College—The Director of Education, 54 Old Steine, Brighton (October 18).

ASSISTANT LECTURER or LECTURER (with special interests in mineralogy and petrology) IN THE DEPARTMENT OF GEOLOGY—The Registrar, University College, Singleton Park, Swansea (October 20).

LECTURER IN PAPERMAKING TECHNOLOGY—The Registrar, Manchester College of Science and Technology, Manchester 1 (October 20).

BIOCHEMIST, Senior grade—The Medical Superintendent, Stobhill General Hospital, Glasgow, N.1 (October 27).

DIRECTOR OF THE COMPUTING UNIT—The Secretary of Faculties, University Registry, Oxford (October 30).

ASSISTANT EXPERIMENTAL OFFICER (preferably with a degree in biology or at least H.S.C. or G.C.E. to advanced level with biology or equivalent) at Merlewood Research Station, Grange-over-Sands, Lancashire, for work on soil invertebrates, including some field work—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (October 31).

ASSISTANTS IN MATHEMATICS—The Secretary of University Court, The University, Glasgow (October 31).

CHAIR OF PSYCHOLOGY in Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

LECTURER IN PSYCHOLOGY—The Registrar (Room 9, O.R.B.), The University, Reading (October 31).

POST-DOCTORAL RESEARCH FELLOW IN ORGANIC CHEMISTRY—The Secretary, The Queen's University, Belfast (October 31).

PRINCIPAL (with high academic qualifications and appropriate educational and administrative experience in a University College or Technical College)—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (October 31).

ERNEST CANNING RESEARCH SCHOLAR (with a good honours degree in metallurgy, chemistry or physics, and industrial or research experience) for fundamental research in metal finishing—The Registrar, The University, Nottingham (November 3).

SOIL PHYSICIST (with a university honours degree in science (with physics as a major subject), together with evidence of research experience, preferably in the field of soil physics) IN THE DIVISION OF SOILS, Commonwealth Scientific and Industrial Research Organization, Adelaide, for research on the movement and measurement of water in soils—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 270/143 (November 3).

CHAIR OF CHEMISTRY in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 8).

LECTURER or ASSISTANT LECTURER IN CHEMICAL ENGINEERING—The Registrar, The University, Leeds 2 (November 12).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOW IN PHYSICS, CHEMISTRY, METALLURGY, ENGINEERING, or GEOLOGY, or in a subject allied to these—The Registrar of the University of Wales, University Registry, Cathays Park, Cardiff (November 15).

LECTURER (preferably with qualifications in one of the following: (*a*) first year teaching in botany; (*b*) algology, especially marine algology; or (*c*) cytology or cytogenetics) IN THE DEPARTMENT OF BOTANY, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, November 15).

LECTURER IN METALLURGY—The Reader in Metallurgy, Department of Metallurgy, University Museum, Parks Road, Oxford (December 1).

LECTURERS (3) and a SENIOR LECTURER IN PHYSICS at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 15).

ANALYST to assist with analysis of materials from animal feeding experiments—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

ANIMAL HUSBANDRY OFFICER (with a university degree in agriculture and practical experience of livestock improvement programmes, especially cattle and pasture work, and preferably with tropical experience) in British Honduras, to be responsible to the Director of Agriculture for the Agricultural Department's livestock policy—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/31/06.

ASSISTANT, Grade B (preferably honours graduate, with teaching, research or industrial experience) IN PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

ASSISTANT PATHOLOGIST IN THE DEPARTMENT OF CANCER RESEARCH—The Secretary, The London Hospital Medical College, Turner Street, London, E.1.

CHAIR OF PHYSICS IN THE UNIVERSITY OF KHARTOUM—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

DEPARTMENTAL ASSISTANT (with a degree in agriculture and considerable practical farming experience) IN AGRICULTURE at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

HEAD (with a good honours degree and experience in the direction and administration of metallurgical research, either academic or industrial) OF THE METALLURGY DIVISION, the work of which is carried on in London and Sheffield and includes both fundamental and applied research in the general and physical metallurgy of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "H.M.D.".

LABORATORY TECHNICIAN to assist with research and class routine—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

LECTURER IN PHARMACEUTICAL CHEMISTRY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

PHYSICIST to assist in physical and clinical work associated with X- and gamma-ray treatment and investigation—The Secretary, Physics Department, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3.

PHYSICISTS (2) or APPLIED MATHEMATICIANS (2) (with an aptitude for experimental work) for fundamental research and development work on the physics and mechanics of certain textile machines and processes; a PHYSICIST or MECHANICAL ENGINEER for fundamental research and development work on the flow of fluids through textiles; and a CHEMIST for analytical work on the investigation of defects in textiles and on the development of new research methods—Dr. D. W. Hill, Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

PRINCIPAL/SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering or chemistry, and/or A.M.I.Chem.E.), to lead a team concerned with chemical process development and plant design studies—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting A.1169/34.

RESEARCH STUDENT (graduate in chemistry or physics) for the study of flames by infra-red spectroscopy—Dr. G. J. Minkoff, Chemical Engineering Department, Imperial College of Science and Technology, London, S.W.7.

SCIENTIFIC OFFICER (Chemist), SCIENTIFIC OFFICER (Biologist), and an ASSISTANT SCIENTIFIC OFFICER in the Metropolitan Police Laboratory—The Secretary, Room 165 (S), New Scotland Yard, London, S.W.1.

SENIOR LECTURER IN MARKET GARDEN AND GLASSHOUSE CROPS—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Reading. National Institute for Research in Dairying. Report 1955. Pp. 148. (Shinfield: National Institute for Research in Dairying (University of Reading), 1956). 4*s*. [88

University of Nottingham. Report of the School of Agriculture, 1955. Pp. 80. (Sutton Bonington, Loughborough: School of Agriculture (University of Nottingham), 1956.) [88

City Museum, Bristol. Report of the Committee for the year ended 30 December 1955. Pp. 20+2 plates. (Bristol: City Museum, 1956.) [88

Scottish Home Department. Freshwater and Salmon Fisheries Research Series, No. 13: Observations on the Spawning Runs of Brown Trout in the South Queich, Loch Leven. By W. R. Munro and K. H. Balmain. Pp. 17. (Edinburgh: H.M. Stationery Office, 1956.) 4*s*. 6*d*. net. [88

United Kingdom Atomic Energy Authority. Second Annual Report for the period 1st April 1955–31st March 1956. Pp. iv+46. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [88

Atom 1956: An Illustrated Summary of the Second Annual Report of the United Kingdom Atomic Energy Authority. Pp. 24. (London: H.M. Stationery Office, 1956.) 1*s*. 6*d*. net. [88

Local Government—Areas and Status of Local Authorities in England and Wales. Pp. 18. (Cmd. 9831.) (London: H.M. Stationery Office, 1956.) 1*s*. net. [88

Ministry of Health. Report of a Working Party on Anaesthetic Explosions including Safety Code for Equipment and Installations. Pp. iv+39. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [88

Department of Scientific and Industrial Research. Report of the Radio Research Board with the Report of the Director of Radio Research for the year 1955. Pp. iv+56+1 plate. (London: H.M. Stationery Office, 1956.) 3*s*. 6*d*. net. [88

Annual Report of the Yorkshire Philosophical Society for the year 1955. Pp. 14. (York: Yorkshire Philosophical Society, 1956.) [88

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Other Countries

Museum of Comparative Zoology at Harvard College. Breviora. No. 54 (June 6, 1956): A Revision of the Genus *Brachymeles* (Scincidae), with descriptions of New Species and Subspecies. By Walter C. Brown. Pp. 19. No. 55 (June 6, 1956): Rediscovery of *Hyla Dorsalis* and *Lechriodis Papuanus* in New Guinea. By Arthur Loveridge. Pp. 4. No. 56 (June 15, 1956): Notes on the Jamaican and Cayman Island Lizards of the Genus *Celestus*. By P. N. Cousens. Pp. 5. No. 57 (June 29, 1956): Three New Species of Mimetidae (Araneae) from Panama. By Arthur M. Chickering. Pp. 15. No. 58 (June 29, 1956): Sequence of Passerine Families (Aves). By E. Mayr and J. C. Greenway, Jr. Pp. 11. Annual Report of the Director of the Museum of Comparative Zoology at Harvard College, 1954–55. Pp. 30. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1956.) [88

Deutsches Hydrographisches Institut, Hamburg. Jahresbericht Nr. 10, für das Jahr 1955. Pp. 82. (Hamburg: Deutsches Hydrographisches Institut, 1956.) [88

Union of South Africa: Department of Commerce and Industries. Division of Fisheries Investigational Report No. 20: Oyster Culture in South Africa—Hydrological, Biological and Ostreological Observations in the Knysna Lagoon, with Notes on Conditions in Other South African Waters. By Dr. P. Korringa. (Reprint from *Commerce and Industry*, March 1956.) Pp. 86 (23 plates). (Pretoria: Government Printer, 1956.) [88

United States Department of Commerce: National Bureau of Standards. Miscellaneous Publication No. 218: Hydraulic Research in the United States, 1956 (including Contributions from Canadian Laboratories). Edited by Helen K. Middleton. Pp. xii+216. (Washington, D.C.: Government Printing Office, 1956). 1.50 dollars. [88

Universitet i Bergen, Arbok 1955. Naturvitenskapelig rekke Nr. 9: The Flight Activity of Twelve Species of East African Trichoptera. By Philip S. Corbet and Audfinn Tjonneland. Pp. 49. (Bergen: A. S. John Griegs Boktrykkeri, 1955.) [88

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Commonwealth of Australia: Department of Supply. Research and Development Branch: Aeronautical Research Laboratories. Annual Report, year 1954–1955. Pp. 24. (Melbourne: Department of Supply, 1956.) [88

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Notas de Física. Vol. 2, No. 9: Polarization of Spin One Particles. By Samuel Wallace MacDowell. Pp. 20. (Rio de Janeiro: Centro Brasileiro de Pesquisas Físicas, 1955.) [88

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Northern Rhodesia: Water Development Department. Annual Report for the year 1955. Pp. 12. (Lusaka: Government Printer, 1956.) [88

Institut des Parcs Nationaux du Congo Belge. Les Buffles du Congo Belge. Par Paul Dalimier. Pp. 68. Exploration du Parc National de la Garamba. Mission H. De Saeger en collaboration avec P. Baert, G. Demoulin, I. Denisoff, J. Martin, M. Micha, A. Noirfalise, P. Schoemaker, G. Troupin et J. Verschuren (1949–1952). Fascicule 4: Flore des Spermatophytes du Parc National de la Garamba. 1: Gymnospermes et Monocotylédones. Par Georges Troupin. Pp. 35. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1955.) [88

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